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# Visualizing article history on Wikipedia

## An exploratory design study

*Master of Science Thesis in Interaction Design*

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# ABSTRACT

The aim of this project was to make the historical content of Wikipedia articles visual and easily accessible to the Wikipedia users. By doing this, the goal was to make it possible for users to see, while reading an article, how it has evolved over time. Based on the design results, an interactive prototype was to be built, demonstrating the results. There were three main objectives for the design, stating that users should be able to see how much an article has been edited, how many have contributed to it, and if some have contributed more than others.

The project was performed as an exploratory design study, using methods such as the 6-3-5-method, extreme characters, personas and prototyping. During the design process, several challenges arose, such as; what metaphor to base the design on; how to use the screen space most efficiently; how to visualize what has been done by different contributors; and, how to distinguish live content from historical content. When a final design was reached, it was implemented into an interactive prototype, which could be used live on Wikipedia, thereby fulfilling the aim and the main objectives of the project.

Some of the main features in the final design includes; dividing historical content into smaller parts based on articles subtopics; distinguishing different contributor types; making the visualization available for the users while reading an article; and providing access to the historical content, making it possible to view it while reading article. Making the history of an article easily accessible have several possible benefits. One such benefit is that it could make it easier for users to value the content in terms of trustworthiness. Easier access to historical content has been requested in previous studies, and after this project, we see no reason to doubt the benefits put forward in those studies.

**Keywords:** Wikipedia, temporal information, information visualization, articles, history, historical content

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# 1. INTRODUCTION

The web, as it is today, is not designed in a way that makes it possible for web users to browse through historical content of a web page. Rather, it is designed for users to navigate to and from current versions of web pages, leaving little or no trace of a page's history. History is, however, an important dimension that should not be forgotten. The history of any object provides information that says something about the object - where it came from and what made it into what it is today. The history of an object is, in a sense, both the parts forming the current version, and a window into what once was. For web pages, the history is the previous versions of a page, containing content that have been removed, and changed, but also content that lay as a foundation for the current content. The old content of a web page can therefore give an insight into where the current content came from, what changes it as undergone and how it was affected by the spirit of different times.

The problem is that history, and historical content, is not woven into the web of today, in a way that makes it as easily accessible, and an as natural part of the web as the live content. There are, however, tools - such as the Wayback Machine[1] - that makes it possible for web users to access past versions of current web pages, but most users are not aware of this possibility (Jatowt et al., 2008). Also, on the one place where users really might want access to historical content - on the web pages they visit - it is simply not available. Users interested in the history of a web page have to browse to web services, such as the Wayback Machine, and search for past versions of the web pages they are interested in. These tools are surely wonderful and of great use, but they do not really bring the history of any web page closer to the page's visitors.

So, what about all old messages, comments and pictures on Facebook, Twitter and Flickr? What about the vast amounts of old news articles stored in the online archives of news websites and blogs? Well, such content is obviously historical, but it is not historical versions of current content. The difference is that it is currently possible to see a list of historical news articles, but it is rarely possible to see historical versions of a single article. Oftentimes, news websites

[1] The Internet Archive Wayback Machine - http://web.archive.org/

publishes articles about ongoing events, and these articles are edited and added to as long as there is new information to publish about the event. However, for a web user visiting the news websites, it is rarely possible to see what such an article looked like at different moments in history. Thus, users are missing out on interesting and perhaps vital information about what once was believed to be true about an event, which could have changed a lot over the lifetime of an article.

One of the few websites that have made historical content of web pages available to its' users is Wikipedia, the worlds largest encyclopedia[2]. Currently, Wikipedia users can view the historical versions of any article by browsing a list of versions (figure 1.1), and they can compare a version of an article to a previous one (figure 1.2), in order to see what information was changed between the two. Making the historical content available on Wikipedia provides the users with information about how articles have evolved into their current form and what was published about a topic at any time in history. Giving users access to historical content on Wikipedia makes them consider the content more trustworthy (Pirolli et al., 2009), and therein lies another benefit of providing access to history, since the quality of Wikipedia articles is usually good and should be considered trustworthy (Giles, 2005). However, the historical content of an article on Wikipedia is not easily accessible when reading the article, users have to navigate to a new page in order to access historical content. This also makes it difficult for users to get an overview of the historical content of an article, while looking at the article. In other words, historical content is accessible on Wikipedia, but not in a way that really invites users to consume it - it is simply not as accessible as it could be. The need for an easier way to access historical content in articles was also requested by the Wikimedia Foundation, the organization behind Wikipedia, when contacted prior to this project.

## Aim and limitations of this thesis project

In order to address the need for an easy access to historical content of web sites in general, and of Wikipedia in particular, the aim of this project was to visualize the temporal evolution of Wikipedia articles, by visualizing the history of an article within the article itself. By doing this,

2 Wikipedia, Largest Encyclopedia - http://en.wikipedia.org/wiki/Wikipedia:Largest_encyclopedia

we wanted to make it possible for users to see how an article has evolved over time, while reading it. The work should result in an interactive prototype, demonstrating the design results of the study. The history will not be visualized for entire articles all at once, but rather a focus will be placed on visualizing how parts of articles have evolved, thus making internal differences such as editing frequency visual. Furthermore, the design activities in this thesis project will be focused on visualizing how much (parts of) an article have been edited, how many have contributed and whether some have contributed more than others to the article content.

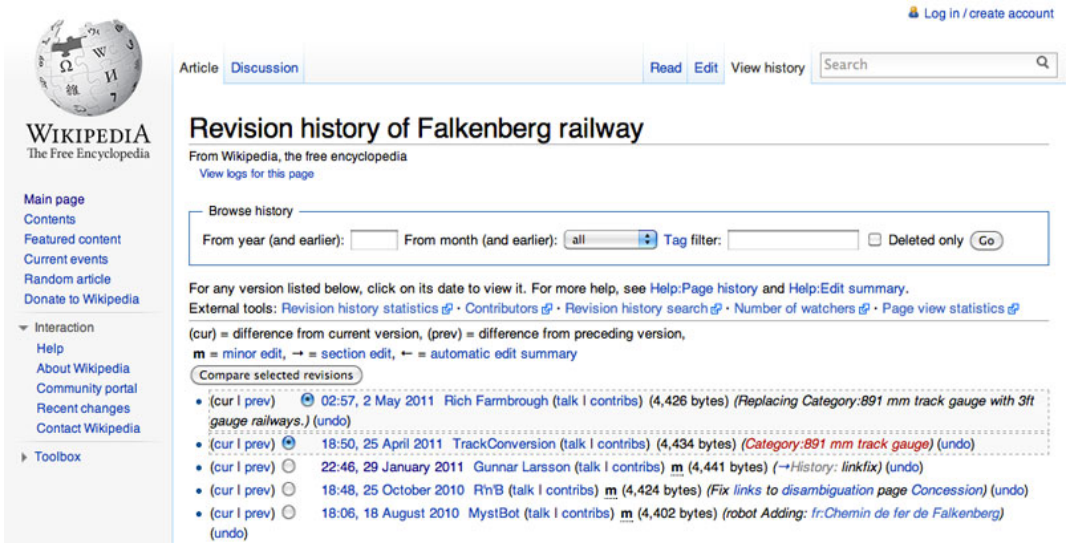


**Figure 1.1** – List of previous versions of an article on Wikipedia (image captured on May 18th, 2011).

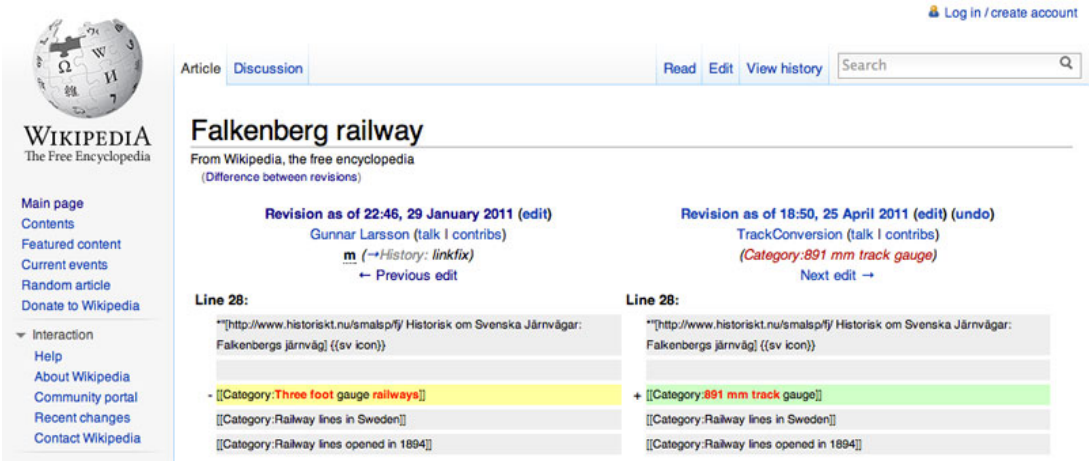


**Figure 1.2** – Comparison of two different versions of an article on Wikipedia (image captured on May 18th, 2011).

# 2. BACKGROUND

The background section will introduce the fundamental topics that this thesis was built upon. The first part provides background information about Wikipedia, its history and how it all works. In the second part temporal aspects will be described along with some examples of how it can be visualized. Third, information visualization will be introduced and some explanatory examples will be provided. Finally, a number of previous projects will be introduced were the temporal aspects of Wikipedia has been visualized.

## 2.1. Wikipedia

Wikipedia[3] is a completely free, web-based encyclopedia, where all content is added and maintained by the visitors themselves (figure 2.1). Any visitor at Wikipedia, registered user or not, is allowed to add new content or edit almost any content in the encyclopedia. Any changes to the content instantly become available to all other visitors, without any approval or validation by administrators. The idea is that when everyone is allowed to contribute, the user-community gets large enough to make sure that the content is trustworthy and free from incorrect information. To do this, any visitors is also allowed to revert changes made by other visitors, in case the change does not comply with Wikipedia's rules about articles and their content [4]. As anyone is allowed to edit the articles, preconceptions about poor quality of the content has flourished among the general public. Even though source criticism is good in most situations, Wikipedia has probably got a worse reputation than it deserves, as studies show that the accuracy of Wikipedia is roughly equivalent to that of Encyclopedia Britannica[5] (Giles, 2005).

[3] Wikipedia, the free encyclopedia - http://www.wikipedia.org

[4] Policies and guidelines on Wikipedia - http://en.wikipedia.org/wiki/Help:Contents/Policies_and_guidelines

[5] Encyclopedia Britannica - http://www.britannica.com


**Figure 2.1** – Wikipedia article, as articles where presented on Wikipedia at the time of this project (image captured on May 18th, 2011).

### 2.1.1. The history of Wikipedia

Built using Wiki software, Wikipedia has grown to be one of the largest *wikis* in the world. The Wiki software was invented by Ward Cunningham in 1995 (Cunningham & Leuf, 2001), as a software and tool for collaboration on the web. Ward decided to name his invention WikiWikiWeb, from the Hawaiian term "wiki" for "quick". Put simple, a Wiki is a tool for knowledge management and consists of a collection of documents that can be edited by any user. Every time something is changed in a document, a new version of the document is created, which makes it possible to trace any change back to its author. A document's historical versions are browsable by any visitor, and the document can be restored to a previous version at any time. This way, vandalism can be managed by rolling back to a revision previous to the inappropriate edit.

Wikipedia was developed out of another web based encyclopedia project called Nupedia. Like Wikipedia, Nupedia was a free online encyclopedia but with the difference that all articles were

authored and reviewed by experts through a formal process. As a parallel project to Nupedia, Wikipedia was launched on January 15, 2001, at the time only supporting the English language. Wikipedia then grew steadily and had 18 language editions by the end of 2001, 26 by late 2002, 46 by the end of 2003, and 161 language editions by the end of 2004[6]. For two years, Nupedia and Wikipedia co-existed, until Nupedia was taken down and its content merged into Wikipedia during 2003. Wikipedia continued to grow, and the English version passed two million articles on September 9, 2007. This was a landmark in the history of Wikipedia, as it then became the largest encyclopedia in the world, passing the former record holder Yongle Encyclopedia, which had held the record for 600 years. Until the time of this study, Wikipedia had continued to grow, with the English version containing more than 3.5 million articles.

### 2.1.2. Wikipedia articles and their evolvement

The content on Wikipedia is ever evolving and articles are added and edited by both registered and anonymous users, every day of the year. Rules and guidelines have been created by the community to ease the content management and to guide the users about what to do and what not. However, if a rule prevents a user from improving Wikipedia, the policy encourages the user to break that rule[7]. Much of the debates and disputes are therefore resolved through discussion between the users. Each added article to Wikipedia receives a dedicated discussion page, where the content of that article can be discussed. Through these pages, the community can agree on subjects such as whether the article is relevant on Wikipedia or not, whether the content deserves a separate article page or if it perhaps can be merged into another article, and how to possibly improve the content.

Even though the vast majority of the Wikipedia users are to be considered "good" users, making valuable contributions to the content of Wikipedia, there is still a problem with vandalism and spam by rouge users. For the user community to be able to let good content predominate the encyclopedia, an important feature of Wikipedia is that it is easier to undo edits than it is to perform them. This makes it easy for the user community to revert inappropriate edits, protecting the articles from abuse. Even though it is easy for users to revert inappropriate revisions,

[6] Wikipedia article about Wikipedia - http://en.wikipedia.org/wiki/Wikipedia

[7] Wikipedia - Ignore all rules - http://en.wikipedia.org/wiki/Wikipedia:Ignore_all_rules

vandalism and spreading of false information was still considered being too much of an issue in some controversial or highly visible topics, that Wikipedia introduced what they call *semi-protected* articles[8]. When an article is semi-protected, only users that have contributed to Wikipedia for some time are allowed to edit the article. This prevents such articles from being abused by new or anonymous users.

To further maintain and preserve the quality of the content, automated user accounts, so called (ro)bots, are allowed to edit Wikipedia as well. Bots[9] are, in contrast to regular Wikipedia accounts, not controlled by a person, but are instead controlled by automated software developed to perform certain editing tasks. The purpose of the bots is various, ranging from vandalism management and spelling correction to searching for ambiguous links or checking for copyright violations. One study (Priedhorsky et al., 2007) showed that the top list of Wikipedia editors (based on edit count) was filled with bots. Bots did occupy the top four positions of the list, nine out of the top ten, and at least twenty out of the top fifty.

Even though the overall quality of the Wikipedia content has been proven good (Giles, 2005), the quality vary between articles. A way to manage the trustworthiness of Wikipedia articles was presented by Adler & de Alfaro (2006), who suggests a user reputation system to make it possible to see the credibility of a certain author. Their user reputation system was based on the evolution of articles, rather than voting among the users for instance. Put simple, a users reputation is calculated based on her contributions to the content on Wikipedia. A contribution that is kept in the article during several revisions adds to the users reputation, while a contribution that is instantly reverted by another user has a negative impact on the users reputation.

### 2.1.3. The Wikipedia user community

It has been debated whether the success of Wikipedia is a result of the collective contributions of a large number of users, or whether a group of "elite" users are responsible for most of the work. Founder of Wikipedia, Jimmy Wales, argues in a webcast (Wales, 2005) that 50% of all

[8] Wikipedia - Semi-protection. http://en.wikipedia.org/wiki/Wikipedia:Protection_policy#Semi-protection

[9] List of registered Wikipedia bots. http://en.wikipedia.org/wiki/Wikipedia:Bots/Status

Wikipedia edits are performed by 0.7% of the users, and that the most active 2% of the users has done 73.4% of all the edits. This clearly states that the majority of the work is done by a few. However, a study by Kittur et al. (Kittur et al., 2007b) finds that although this was true early on in the history of Wikipedia, a dramatic shift in workload has occurred towards the more common users, with a corresponding decline in influence by the elite users. One interesting note however, is that elite users on average add more words per edit than the more common user, who on average remove more words than they add (Kittur et al., 2007b).

Unfortunately, the freedom of editing on Wikipedia is not seldom misused by some users of the community. Articles are used to spread misinformation and offensive messages, get cluttered by spam and nonsense text, and get incorrectly deleted by saboteurs. One study (Potthast et al., 2008) distinguishes three groups of users that misuse this freedom: *lobbyists*, who try to spread their own agenda, *spammers*, who try to market products and services, and *vandals*, who intentionally ruin the work of other users. Such bad behavior is troublesome for the Wikipedia community and studies (Kittur et al., 2007a) show that even though Wikipedia continues to grow, the rate of new articles and content is dropping, while the level of maintenance needed is on the rise. To deal with this, work has been done on a conflict prediction model for Wikipedia articles (Kittur et al., 2007a) that has been proven successful in predicting conflicts in various articles. By using such models, it might be possible to predict conflicts and increase the number of contributors for a given article, to solve the controversy before it reaches a critical point.

## 2.2. Temporal aspects in design

In design, when talking about elements that are related to time, these are often referred to as the temporal aspects of the design. When working with design, time can be considered to various extent, ranging from ignoring its existence to using it as an important design material (Lundgren, 2010). However, when it comes to interaction design, Lundgren states that ignorance is far more common and that the interaction design community has not really acknowledged time as an important design material. Further, Redström (2001) argues that time is a parameter that far too often simply is considered as something we want to reduce, for instance reducing the time it takes to perform a certain task.

In the real world, physical objects can tell us a lot about how people have used them in the past, which in turn can transfer gained information from a previous user to a later one. In a book, notes and folded pages can tell us what content was interesting to readers before us, pages that opens easily have probably been read more than others, and so on. As time is allowed to set its mark on objects, valuable information becomes available to those who use it. Wexelblat (Wexelblat, 1998) and later also Wexelblat & Maes (Wexelblat & Maes, 1999) refers to this as the objects' *interaction history,* and notes that such useful information about previous usage is not present in digital content today, thus the users lack possibly valuable information.

History of digital content has been studied by Jatowt et al. (Jatowt et al., 2008), who looked at the historical aspects of the web by identifying different ways for users to interact with historical content. The authors believe that the benefits of integrating documents with their histories are many, including making it easier to travel back in time to determine a document's trustworthiness. Also the ability to discover past content and to see the documents frequency of change could be useful tools when studying content for various reasons. From a user study, it was found that many users were interested in getting access to historical content, but not that many were actually using the existing web archives for historical versions of web pages. By developing applications that make document- and interaction history available, the users actual needs can be evaluated and the users can be made more aware of the historical content that is available.

In a project called TemporalNotepad (Gunnarsson et. al., 2010), experiments were made where time was added as an extra dimension in a text editor. In ordinary text editors, if you leave your document open for five hours while you take a break, when you later get back to writing it is as if time have stood still within the document. Instead of ignoring time, as ordinary text editors do, TemporalNotepad add the temporal dimension to the document using text color. Different color tones where used to indicate what hour of the day the text was written. The text faded into black as it aged, resulting in that newly written or moved text stood out visually. The purpose of adding the temporal dimension was to make it easier to find a certain part of the text, based on that the writer knew approximately when she wrote it.

Another example of how temporal aspects can be used, in this case history of web pages, was presented by Jatowt et al. (Jatowt et al., 2006). During the study, a *past web browser* was developed and evaluated as a way to make the historical content of the web as easily accessible as live content. Two types of browsing were identified; vertical browsing, which was browsing through historical versions of a web page; and horizontal browsing, where the user browses the web as it was at a given time in history. To assist different users different needs, several interaction possibilities were added to the browser, such as the ability to bookmark a certain point in time for a given web page, making it possible to return to that version of the page later on. The past web browser shows both how content was added to a page, as well as how it was removed or moved around, making it possible to see how the overall content had changed through time. The authors found several advantages of making historical versions of a web page available, which include; many users may found it interesting to browse the history of their favorite pages to see content that might not be available any more; it might be easier to understand an element on a page when seeing it in the context where it was first introduced; detecting the age of a page element by going back to where it was first introduced.

When designing for temporal aspects Wexelblat & Maes (Wexelblat & Maes, 1999) recognizes several questions that needs to be addressed. One question is how to deal with the constantly growing amount of information as time passes on, which they suggest could be addressed by summarizing the historical information and not displaying it all at once. Another question is how tight the link between the object of interaction and the historical information should be - what information should be accessible and by what means. A third question is whether to display personal or social histories. In other words, should you display the history created by the user herself only, or the history created by everyone who has been in contact with the object. Wexelblat & Maes argue that social interaction history is preferable since it could help newcomers benefit of work done before them. Other questions to ask when designing for interaction history is concerned with what information to display; showing *what* has been done before; showing *who* has done something; *why* something was done; and *how* it was done. Based on this kind of information, social aspects of usage could be improved by letting users see what users similar to them did, how they did it and why.

# 2.3. Information visualization

The field of information visualization is concerned with visualizing complex data, turning it into images and illustrations, often making the visualizations interactive and dynamic. A common reason for using information visualization is to amplify the human cognition abilities, in order to make it easier for humans to understand and make use of complex data (Preece et al., 2002). By using features that the human mind finds easy to perceive, such as color, size, shape, proximity and motion, information visualizations presents data in a way that is suitable for humans, as described by Geisler (1998, p. 3):

> *"Because we perceive such features so readily, and because each feature can be used to represent different attributes of data, good visualizations enable us to not only perceive information more easily but also to perceive more information at one time. We can immediately see patterns in data that indicate trends, recognize gaps in the data, discover outliers or errors in the data, pinpoint minimum and maximum values, and identify clusters. As a result, information visualization applications enable us to better understand complex systems, make better decisions, and discover information that might otherwise remain unknown."*

The value of using information visualization in order to help people easily and quickly derive information from data is also noted by Spence (2007). To illustrate the power of information visualization, Spence tells a story about the Serious Fraud Office in the UK, who spent eight person years going through data to identify a building society fraud. They found the responsible person, and justice was served. However, the same task was later given to single person, with access to visualizations of the same data. This time, the perpetrator was found in just four man weeks, which is a hundred times faster than when no information visualization was used.

The design of information visualizations is often about adding a lot if information into a limited space, depicting various aspects of a data set. When adding a lot of data into a single view, there is always a risk that the display gets cluttered and perplexing. However, Tufte (2006) argue that such clutter is simply a failure in design, not an attribute of the information itself. An easy way

out would be to simply reduce the amount of information in the visualization, thus making it less cluttered. Tufte, however, argues that visual problems should not be solved by reducing the content-resolution (removing data labels etc.), rather he suggest designers "fix the design" (Tufte, 2006, p. 121) in order to make it less cluttered and easier to grasp.

### 2.3.1. Visualizations of temporal information

As pointed out by Jatowt et al. (2008), there has been a lack of projects focusing on making historical versions of web content accessible to web users. However, some studies have been conducted in which the dimension of time has been made accessible in the shape of information visualizations. Visualizing temporal aspects does not necessarily provide users access to historical content, but it gives them easier access to, and perhaps understanding of, information about the past. One such project, focusing on making temporal information visible, was that of Wexelblat & Maes (1999). They developed *Footprint tools*, a series of tools that have made use of interaction history in navigation. The first Footprint tool allowed users to navigate websites by seeing what paths other visitors had taken on the websites before them (Wexelblat & Maes, 1997). This was shown in a site map (figure 2.2) that displays each visited page as a node and the lines between nodes were color coded to show level of activity on the link between two given nodes. From their experiments, Wexelblat & Maes found that the tools, utilizing historical information about other users interaction patterns, helped users do their work faster and with a higher sense of satisfaction.

Another study in which temporal information was made visible was that of Viégas et al. (2006), who built Themail. Themail visualizes people's e-mail history, using the content of past e-mail conversations and various font sizes and colors to display words that were used often, both monthly and yearly. The most used words on a monthly basis were displayed in columns on a timeline (figure 2.3), as were the words most used each year - though these columns are not as frequent since they only display words that where common for the particular year. Yearly words would depict the overall nature of an email conversation, displaying words like 'love', 'hug' och 'Thanksgiving' for family conversations, whereas monthly words were a lot more time specific. This resulted in two different kinds of usage, the *haystack* mode (used by 80% of the users) and *needle* mode (20% of the users). Users in haystack mode wanted to see overall patterns and topics in different conversations, whereas users in needle mode wanted to see particulars such as

when they discussed a given topic with someone - often work related. This shows how visualizing content history can, if made right, support different users and their different needs at the same time.

In a study by Dubinko et al. (2007), the temporal evolution of tags within the community of Flickr[10] was studied and visualized. Two different ways of displaying tags over time were chosen; using a waterfall metaphor; and by using a river metaphor (figure 2.4) - both metaphors displaying tags as floating like water as time goes by. Users could then interact with the display of tags by using the pointer of a bar or play/pause, forward/reverse controls to alter the time to display. The most interesting tags from a given time period were chosen, and displayed, based on two properties. First, a tag would be considered more interesting if it occurred more often inside a give interval of time than it did outside the interval. Second, a tag that is only common during a single interval in time is not necessarily to be considered interesting for that interval. By evaluating what tags are to be interesting or not, the most frequently used tags for the displayed period of time could be shown, making it possible to get an overview of what topics are frequent during different time periods.

A study on themes in large collections of documents over time, by Havre et al. (2002), also used rivers as a metaphor for visualizing temporal information, Similar to Dubinko et al. In their system, called *ThemeRiver*, themes common in documents during certain periods in time is displayed by depicting them as water in a river. Themes with high strength or degree of representations are shown as waves, or peaks, in the river of themes. A theme is present even when it is not often represented by thin lines in the river instead of large peaks. Using the macro-perspective of changes in themes in documents over time, the authors found ThemeRiver to be valuable for information analysts.

[10] Flickr, a social network where users share photos and images - www.flickr.com

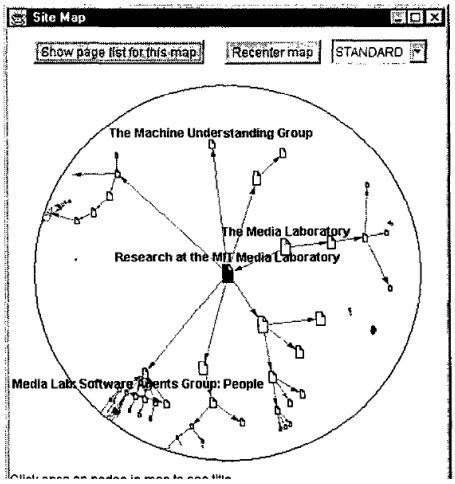


**Figure 2.2** - Site map from Footprint tools, showing paths taken by other visitors to a page. Color of the lines changed depending on how much visits a document received. Image source: Wexelblat & Maes (1997)

**Figure 2.3** - Themail, visualizing common words in e-mail conversations over time. Image source: Viégas et al. (2006)

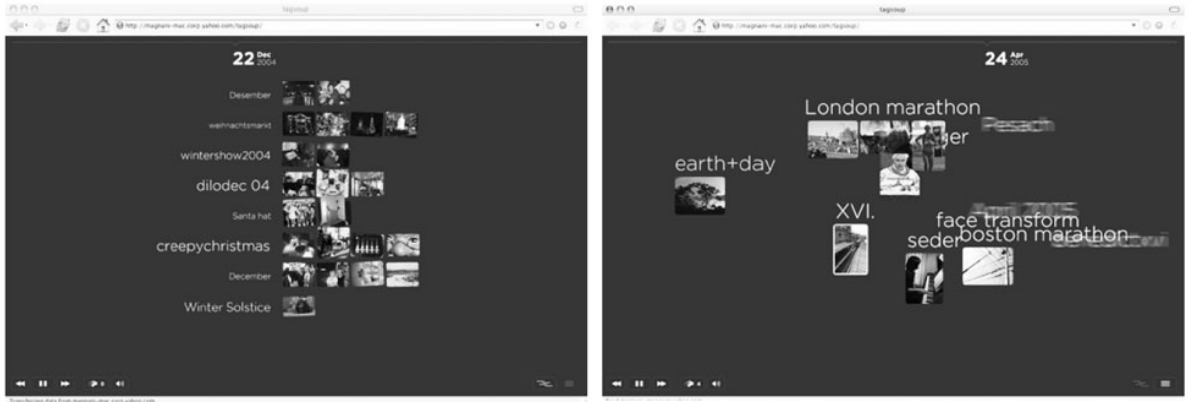


**Figure 2.4** - Temporal evolution of Flickr tags made visible via a Waterfall metaphor (left) and a River metaphor (right). Image souce: Dubinko et al (2007)

Some tools have focused on making historical content accessible to the users, in the sense that historical versions of files and documents can be accessed and viewed. This kind of tools often displays historical versions of content as lists, where each version is represented by one row in the list. One such tool is the 'Version history' view in Dropbox[11], which contains information about actions performed on a document placed in a Dropbox folder (figure 2.5). Each action performed on the document, such as adding the document to a folder or editing it, is displayed together with information about when the action occurred, who performed it and how the file size was affected. It is also possible for users to choose old version of a document, and restore the documents' content to that of the old version, thus making the temporal information accessible to the users. Temporal information is also made visual in Microsoft Word, where users can choose to 'Track changes' made to a document. In this case, the text of a document is displayed along with edits made to it, such as text being removed. Texts that have changed is highlighted in different colors depending on what users made the editing, and the name of the editor as well as the timestamp of when the edit was made is displayed (figure 2.6).

Klemmer et al (2002) built a tool that both visualized historical content to some extent, as well as made it accessible. Their system made it possible for designers to access their old designs through thumbnails on a timeline (figure 2.7). Each thumbnail represented the interface (a smartboard) as it looked at a given point in time, with elements that was altered in recent frames

[11] Dropbox, a web based file storage application - www.dropbox.com

being highlighted for the user to identify. The interface allows users to see all changes in the designs, but also to filter by activity (based on an action, a bookmark or a design meeting) or by filters such as time or author. Users can click on any thumbnail to restore the interface to that state, making them more free to try out different designs since the can always move back and forward in time (undo/redo).

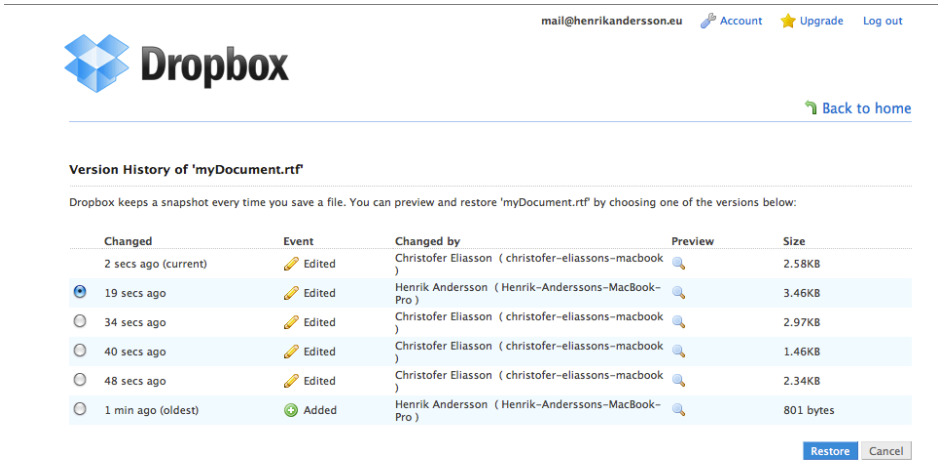


**Figure 2.5** - Version history of a document in Dropbox.

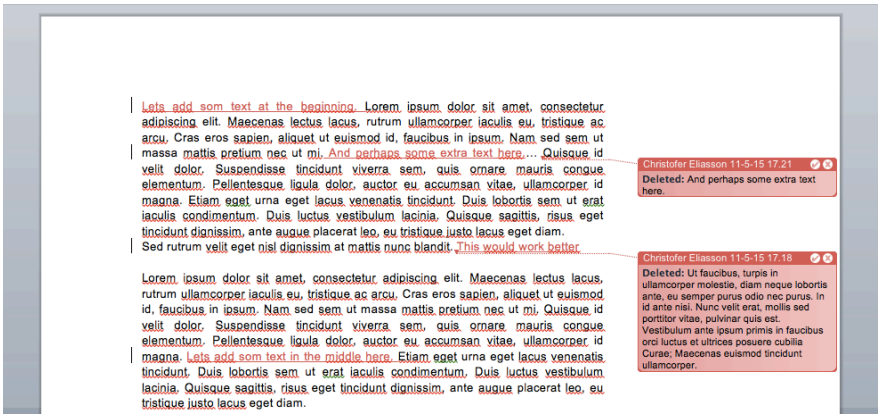


**Figure 2.6** - Edits made to a document in Microsoft Word.

**Figure 2.7** - A smartboard tool for designers, making it possible go travel backwards in time to see what the board looked like at different points in time.

## 2.3.2. Visualizations of Wikipedia data

Wikipedia has been the subject of many information visualization projects throughout the years. Some projects[12] have focused on visualizing important words in articles, others show near real-time information about edits being made to Wikipedia articles, yet others make visible the most visited articles on the website. One visualization by Chevalier et al. (2010) was made in order to make it easier for casual Wikipedia readers to judge the quality of a Wikipedia article. The tool, called *WikipediaViz*, consists of a number of graphs and statistical data visualizations that is displayed on the left side of the articles (figure 2.8). Including word count, number of contributors, number of internal links and more, the authors argue that it is made easier for casual users to assess the quality of the content of an article they are reading.

Conflicts were also the topic for a study by Suh et al. (Suh et al., 2007), who looked at so called "reverts", where one user revert another users version. Such reverts were used to visualize conflict patterns between groups of Wikipedia users. In the *Revert Graph*, as they call it, each

[12] Wikipedia visualizations - http://infodisiac.com/Wikimedia/Visualizations

user is represented as a node in a node-link graph. All nodes in the graph normally attract each other, however if a revert relationship exist between any two users, those users will be pushed apart (figure 2.9). By doing this, social relationships could be visualized, revealing user conflict patterns, like opinion groups, controversial editors and users who fight vandalism.

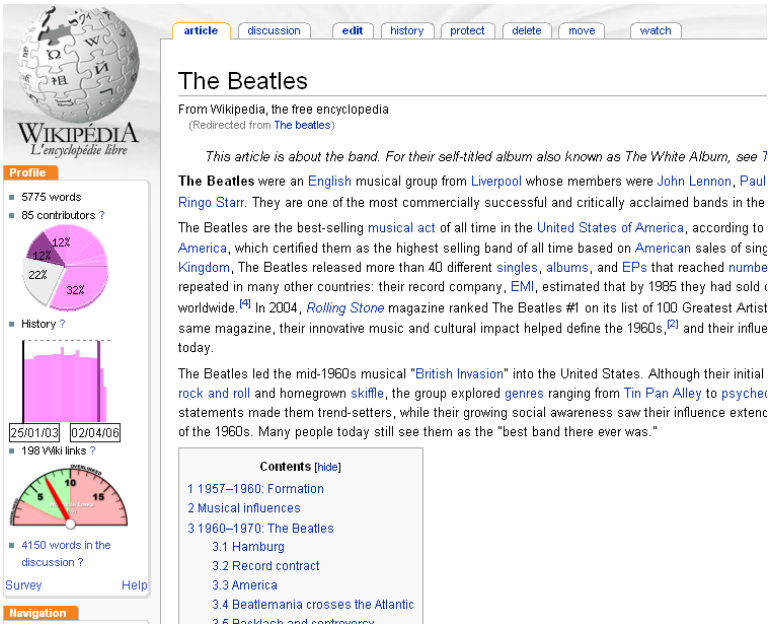


**Figure 2.8** - The WikipediaViz project, where information about the article was added to make it more easy for the users to judge its quality. Image source: http://www.aviz.fr/wikipediaviz/

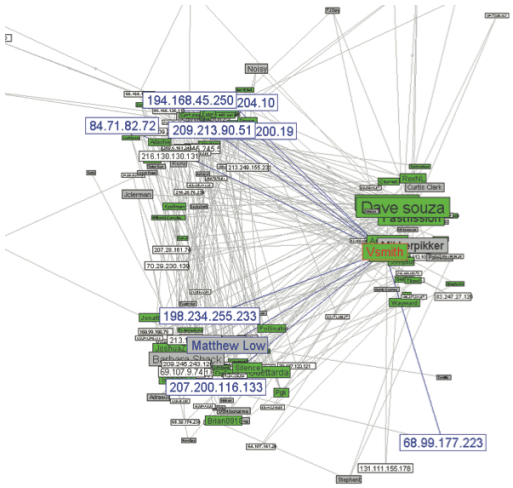


**Figure 2.9** - RevertGraph revealed conflict patterns based on reverts. Source: (Suh et al., 2007).

Adler et al. (2008) focused on visualizing trustworthiness of the content in Wikipedia articles. Using an algorithm, the trust of each individual word in an article was calculated, and visualized by varying the background color of the written text. This made it possible for readers of an article to see what parts of the article were to be considered trustworthy, and what parts were not. The background color of the text was orange, and the less trustworthy the text, the darker shade of orange would the background be. An example was presented, where the name of Danish former prime minister, Anders Fogh Rasmussen was changed from Fogh to Fjogh, turning the background color of the text to a darker shade of orange (figure 2.10).

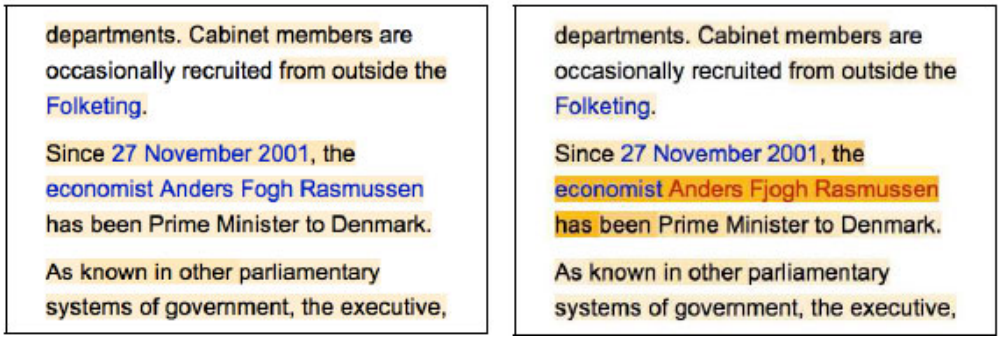


**Figure 2.10** - Background color indicating trustworthiness - the darker shade of orange, the less trustworthy

# 2.4. Visualizing temporal aspects on Wikipedia

The aim of this thesis was to visualize the temporal evolution of Wikipedia articles, by visualizing the history of an article within the article itself. Even though no prior projects with the same focus have been found, previous work with a related approach does exist. In a number of different projects Wikipedia data has been used to visualize various temporal aspects.

A team of researches from MIT Media Lab and IBM Research introduced a new visualization method called *history flow* (Viégas et al., 2004), which was a data analysis tool that highlighted collaboration patterns that appeared when multiple visitors contributed to the same Wikipedia article. In a history flow diagram (figure 2.11), each revision was presented as a vertical line, where the length of the line was proportional to the length of the revisions content. Each contributor was assigned with a different color, and sections of the revision line were colored

based on who wrote that piece. Sections that were kept between revisions were then visually connected by drawing shaded connections between the revision lines. By doing this, the evolution of an article could be visualized, revealing editing patterns that emerged within Wikipedia. One such pattern that became visible was the characteristic zigzag pattern, that was the result of an editing war, where two users continuously reverted each others edits.

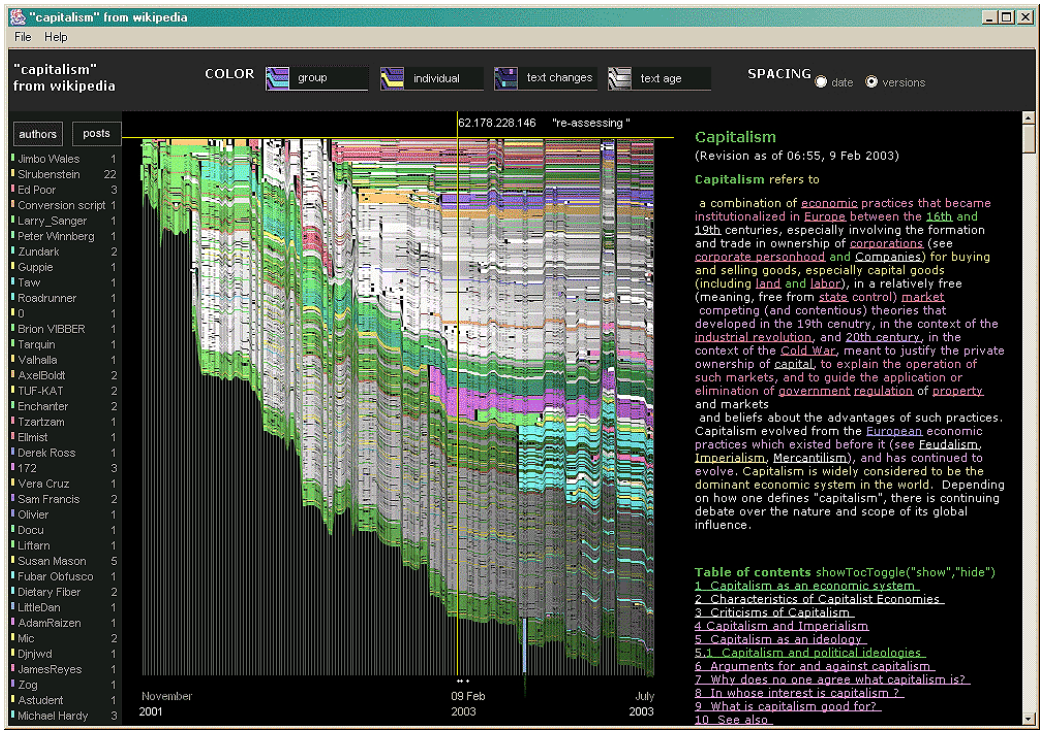


**Figure 2.11** - With a History Flow diagram it was possible to reveal different editing patterns based on a Wikipedia article.
Image source: http://www.research.ibm.com/visual/projects/history_flow/

In another related study conducted by Wattenberg et al. (Wattenberg et al., 2007) the activity of individual Wikipedia contributors were visualized by converting textual data into colors, arranging small colored boxes into what they call a *chromogram* (figure 2.12). By mapping colors to words in titles and revision comments, they were able to produce data-dense displays that could visualize even vast editing histories, on a single screen. The color of the box was determined by the three first letters of the title, where the first letter determined the hue, the second letter the saturation and the third letter the brightness of the color. As arbitrary as the approach may sound, the chromogram diagram was still able to reveal interesting patterns about how individual users edit Wikipedia. One such pattern was revealed in the example image

(figure 2.12), where one user has chosen to focus his editing on a specific topic. The purple color in the image is that of the abbreviation USS (United States Ship), used in the names of American vessels. Thus, even though the occasional appearance of another color, this user has focused his editing on articles about the US naval fleet.

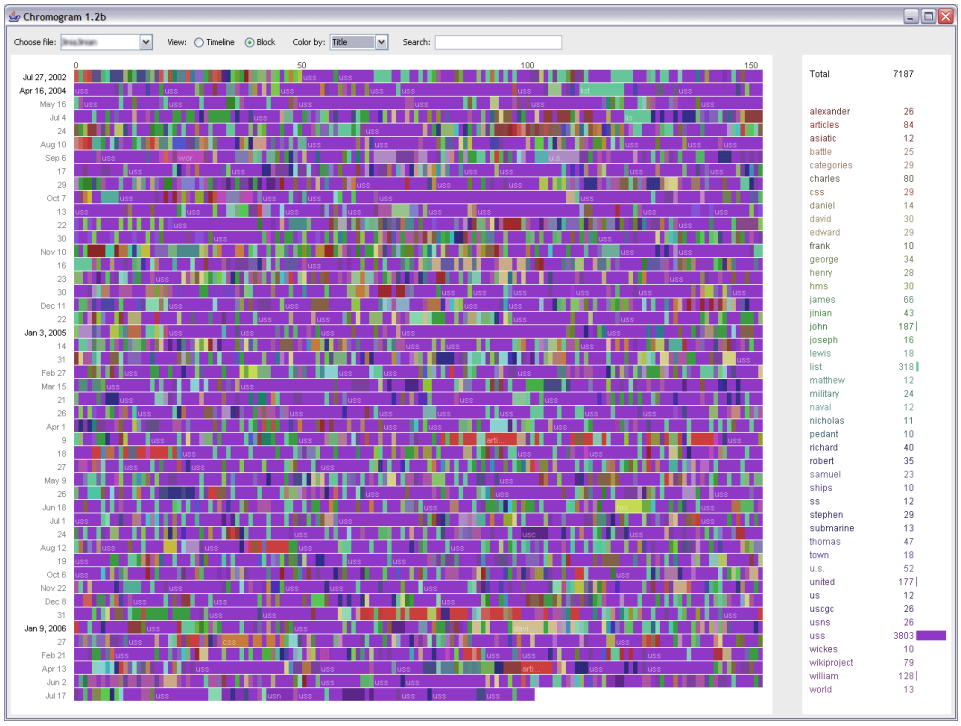


**Figure 2.12** - A chromogram diagram, visualizing a user who has performed a large number of edits on articles about US ships (purple boxes). All such articles start with the same abbreviation USS (United States Ship), thus all given the same purple color.
Image source: http://www.research.ibm.com/visual/projects/chromogram.html

A study by Cross (2006) focused on trustworthiness of content in Wikipedia articles based on the maturity of the text. A piece of text that had been kept in the article a long time, through many article revisions, would be considered more likely to be reliable, and therefore distinguished from other texts. Text that recently had been written was colored red, somewhat older text was colored yellow and even older texts were green. Text that was colored black was considered mature and therefore reliable (figure 2.13).

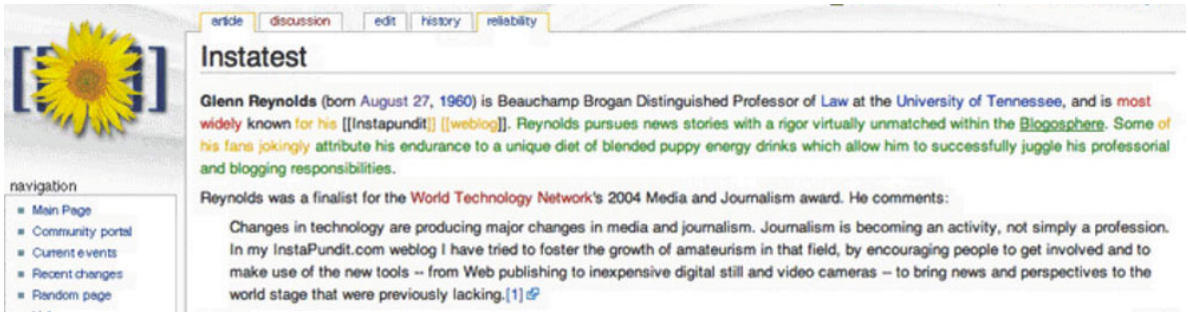


**Figure 2.13** - Text being colored based on how long ago it was written. Going from red (new text), to yellow, green and finally black (old text). Image source: Cross (2006).

In yet another study, probably the one most similar to this, Pirolli et al. (Pirolli et al., 2009) gave Wikipedia users access to the editing history of articles and authors in order to study credibility judgments about Wikipedia content. Their *WikiDashboard* (figure 2.14) displayed an article's editing history and the contributing authors, on the same page as the live Wikipedia content of an article. With the WikiDashboard it was possible to see how many authors had contributed to an article, who they were and how much they had contributed. The information was made available as a set of graphs and timelines, presented in between the article title and the article content on the Wikipedia page. During user testing, it was found that WikiDashboard gave users a better ability to judge the credibility of Wikipedia articles. This indicates interesting potential for the design put forward in this report, as it in some aspects is similar to the WikiDashboard.

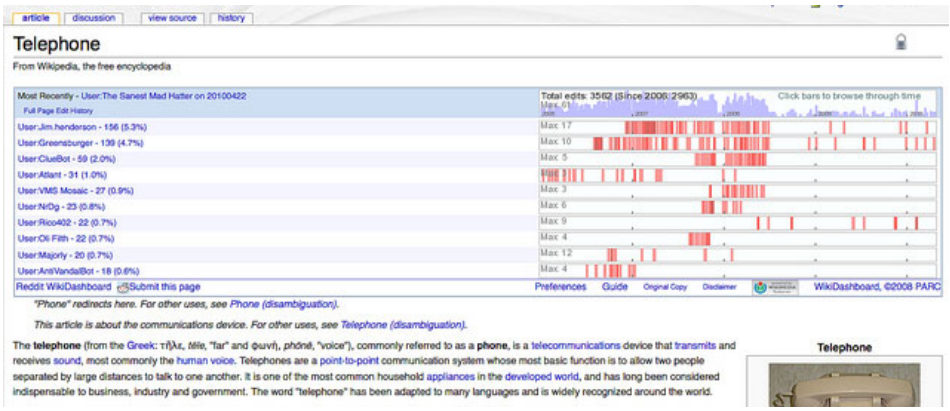


**Figure 2.14** - The WikiDashboard made information about the article's history and the different contributors available within the Wikipedia article itself. Image source: http://www.flickr.com/photos/gregelin/4544246318/sizes/z/in/photostream/

# 3. METHOD

As the research area was somewhat unexplored, it required the project to take an exploratory research approach (Patton, 1990). A lot of the early work consequently was about exploring and understanding the problem area at hand, studying Wikipedia and how article history had been used prior to this study. The project had no definite goals on how the visualization should be achieved, and much of the design work therefore was about evaluating different design concepts, finding the one most suitable for this context. To enable the creativity needed for such exploratory design work, a range of methods and techniques were used throughout the project.

## 3.1. Methods and techniques

During the study both academic and design oriented methods and techniques have been used to understand the problem area, spark creativity and evaluate ideas. This section introduces some of the methods and techniques used throughout the project.

### 3.1.1. Literature searching

Jones (1992) describes a six-step process for literature searching that, according to the author is suitable for any literature search that is likely to take more than an hour or two. In the *first step*, the purposes for the literature search i defined, which could be "to learn more about the field of study" e.g. The *second step* is about identifying what publications to search for information in, about the subject at hand, i.e. what publications are most likely to contain relevant information. When the parameters for the search is defined, one should choose a few methods for how to begin the information search, this is *step three*. Jones mentions eight different methods for this step:

- Looking in encyclopedias for information or references to experts and their publications
- Using library catalogues and indexes
- Consulting librarians or relevant information staff
- Calling, interviewing or writing to experts

- Looking in abstracting journals
- Using keyword indexes, most likely to be found in industry specific organizations
- Consulting an expert in the field, someone who is likely to know useful publications to look for.
- Consulting periodicals

*Step four* is about keeping control of cost and time for the literature search, in order to not end up with unusable information and no time left to correct the situation. This could happen if not enough time is spent on evaluating various documents' relevance to the problem at hand before identifying, retrieving and reading the documents. Eight hints for how to keep control over the literature study is listed by Jones:

- Decide when the literature search must by completed in order to influence the design
- Plan for delays that can occur when trying to retrieve documents from various sources
- Keep the number of sources to search via to a minimum in the beginning
- Consult experts in order to prioritize what documents to look for
- Let the repute of the author and publisher be a guide when no other basis for selection among documents is available.
- Read some of the documents from each source early in order to evaluate their usefulness to the problem at hand.
- Observe and think about the design situation before performing the literature search in order to be able to quickly reject documents as not suitable later on.
- Use rapid reading techniques to quickly identify interesting information and increase the amount of retrieved information. Rapid reading can be performed by looking at a page three times, first time spending about 10 seconds looking at the page, the second time spending about 20 seconds and then reading more slowly the third time. This could, according to Jones, halve the total reading time.

Jones also advices one to keep complete references to the used documents (*step five*) and to keep the local collections of documents small and free of unnecessary documents in order to make documents retrieval quicker later on (*step six*).

### 3.1.2. Stating objectives

In any design activity, it is important and advantageous to consider and state objectives, especially when the designers do not have previous experience of the thing that they are designing (Jones, 1992). According to Jones, the activity of stating objectives should start with identification of the situation in which the design is going to be used. When the situation is identified, it could be useful to get an overview of the situation through Literature searching, user interviews or other methods that might give an insight into the current state. At this point, features of the situation that the design must be compatible with in order to be accepted should be identified. This activity consists of identifying expectations on the system, identifying available resources for the system design and - perhaps most importantly - identifying essential objectives, i.e. objectives that, if not met could invalidate the design. The final activity in stating objectives is to look at the essential objectives and make sure that they are compatible - both with each other and with information that is gained throughout the design process. For instance, an objective that states that a system must be protected by a login-mechanism for members will not be compatible with an objective stating that the system must be accessible for anyone.

The stating of objectives could, as Jones notes, be a lot more time consuming than simply having meetings to discuss the design in the beginning of the design process. However, the time spent on stating objectives will be worth the cost if it helps avoid terminating the project because of incompatible objectives or misunderstandings.

### 3.1.3. 6-3-5-method

The 6-3-5-method, sometimes referred to as 6-3-5 Brainwriting, is a more structured version of brainstorming (see below), developed by Rohrbach (1969). The basic idea is that six participants start of by getting a thorough understanding of the problem, and then write down three rough ideas on how to solve it. The three ideas are then sent to the next participant, who read through the ideas and add three more ideas or modifications. This continues until all participants has improved or revised all the original ideas - six participants, three ideas, five rounds of

supplements: 6-3-5 (Löwgren & Stolterman, 2007). One of the benefits of the 6-3-5-method is the large number of ideas that are generated during the process - six participants generating three ideas each in every round during six rounds result in 108 ideas or modification of ideas, on how to solve the problem. On the other hand, you may loose some of the group dynamics that spark creative ideas, since the participants do not discuss the problem during the process (Löwgren & Stolterman, 2007).

### 3.1.4. KJ-mehtod

The KJ-method (Scupin, 1997), sometimes called Affinity diagram (Spool, 2004), is a group consensus technique that was invented by Japanese ethnologist Jiro Kawakita to help interpret ethnographic data from Nepal. Often when there is a lot of qualitative data (like after a brainstorm session), group members individually identify different aspects and build their own opinions about what is important to consider. In these cases the KJ-method could be useful in order to reach consensus and share perspectives among members of the group. When using the KJ-method, a question that the group should try to answer collectively is determined - an example could be "Which features do the users want?". Then, the participants are given sticky notes, and should individually start writing down as many items as they can come up with (one per sticky note), based on the determined question. When everyone has written down all they can think of, each participant should place their sticky notes randomly on the wall for the others to read. Whenever someone thinks of a new item, based on what others have written down, this should also be written on a sticky note and placed on the wall. Now the participants should start to group similar items together, forming clusters of sticky notes with common items. This is where the group consensus really starts, as the participants gets an overview of which items are common among the group members and which are not. Then each group of sticky notes should be given a name that best represents what is written on the notes. When all groups have been given an name, the participants should start prioritizing which groups are the most important to consider, which completes the KJ-method session. The group should now have a common answer to the question determined earlier, since everyone's opinion and perspective was taken into account.

### 3.1.5. Brainstorming

A common idea generation method is brainstorming, first introduced by Osborn (1963). During the years the method has been presented in a wide range of variations, with slightly different processes and with different supporting tools. This study relied on a version mainly described by Jones (1992) and Landqvist (1994). The basic idea of brainstorming is to gather a group of people with the purpose of generating, and later organizing, a large number of ideas based on a specific problem (Löwgren & Stolterman, 2007). When all participants are gathered and understand the problem at hand, the idea generation process starts. Every new idea that come up is immediately written down on a piece of paper and presented to the rest of the group. This way, the group can be inspired and further develop the ideas that arise. During the idea generation process no participant is allowed to criticize or question an idea by another participant - the purpose is to generate as many ideas as possible. When the idea generation process ends, it is time to organize and structure all the generated ideas. This work can be done in many ways, but a common solution is to construct an affinity diagram (see KJ-method). The structuring process is often time consuming and generally has to be done in iterations, to finally reach consensus. However, it is only when the structuring process is done thoroughly that brainstorming reaches its full potential (Löwgren & Stolterman, 2007).

### 3.1.6. Using metaphors

When trying to come up with new directions for a design, one sometimes experiences a mental block, where no new and fresh ideas seem to come to mind. In such cases it could be useful to try various techniques for freeing the mind and allowing oneself to think in new directions (Jones, 1992). Using metaphors to remove mental blocks is one such technique that could be useful (Löwgren & Stolterman, 2007). Instead of thinking about the problem at hand in the same way as one did in the beginning, a metaphor could be used to explore new grounds for seeking ideas. This is a simple technique where participants try to come up with a metaphor for the system or problem at hand. When thinking about a system as something entirely different, new possibilities and problems arise, which could be used and dealt with, and sometimes the solutions and new possibilities are transferable to the current design. This technique could be used separately, or as a part of a brainstorm session for example.

### 3.1.7. Prototyping

Preece et al. (2002) argues that prototypes are useful for purposes such as testing feasibility of an idea, clarifying requirements, evaluation and testing on users, and to determine if a design works well with other parts of a system. It can also be useful for discussing and communicating among group members and with stakeholders. Prototypes could look very differently depending on the purpose for which a prototype is developed. If, for example, the purpose is to evaluate what basic design metaphor users find most natural, then a paper-based mockup might be enough. But if the purpose is to test how well a certain feature functions together with the rest of a system, then paper-based mockups will be of little use. Preece et al. devides prototypes into two main categories; low-fidelity prototypes and high-fidelity prototypes.

*Low-fidelity prototypes* are simpler and less complex than high-fidelity prototypes and they do not necessarily look very much like the final product (Preece et al., 2002). A prototype of this sort could be a paper-based mockup or a storyboard, which is a cartoon-like sketch of how a product could be used. Digital designs (from e.g. Photoshop) and simple, non functional versions of a system is also a kind of low-fidelity prototype. Such prototypes could be used along with the *Wizard of Oz method* [13] to perform tests on user interaction with a system that is still being designed. Since Low-fidelity prototypes are cheep and easy to produce and to modify and gives designers rapid feedback, they are extra useful in the early stages of a design process, where a lot is unclear and still open for change.

*High-fidelity prototypes* are more alike the final system than low-fidelity prototypes, and could be early versions of the final system (Preece et al., 2002). Because they are more advanced they are also more expensive and time consuming to develop, and cannot be changed as easily as low-fidelity prototypes. Another disadvantage of using high-fidelity prototypes is that users tend to focus on layout and design of such prototypes rather than the functionality when tests are performed. Also, developers are often unwilling to change what they spent time on developing.

[13] Wizard of Oz (Preece, 2002) is a prototyping method that allows for users to interact with a system where there is no complete functionality behind the interface. Instead, a human (the "Wizard") simulates system responses whenever a user interacts with the system.

High-fidelity prototypes can however be useful when trying to sell a system or to test how well a certain technical solution works in practice.

### 3.1.8. Extreme characters

When designing products and applications, it is common to write scenarios and create personas that can be used as representations of a particular target group. A problem with these representations is that the created characters often only posses character traits that are positive and desirable, thus ignoring the full spectrum of human emotions and characteristics (Djajadiningrat et. al., 2000). Extreme characters is a method that can be used to steer away from designing for stereotypical characters, by instead thinking of people with exaggerated character traits - extreme characters. By doing this, you allow your self to expose less desirable character traits which, even though they are common, often remain hidden because of their risk to create conflicts. When exposed, the designer can consider these traits, and design a product that is more suitable for the actual user. Extreme characters can also be used as a method to break through mental blocks, where the designer no longer can think of new and fresh ideas. Extreme characters can then be used to get a new perspective on the problem at hand - *"How would Snoop Dogg use this? Or the pope?"*. This raises new challenges and put the product in an entirely different context, which in turn can spark new ideas.

### 3.1.9. Personas

Personas are fictional characters that, according to Pruitt & Grundin (2002), can be a better alternative to writing scenarios in product design. When faced with a well-written persona, people tend to imagine them in new situations and thereby exploring various problems and opportunities. In scenarios, on the other hand, the situation is described in detail and people are therefore not as easily engaged in the scenario as they would be trying to place a persona i various situations. In that aspect, personas can be considered more generative than techniques such as scenarios. Personas can also help team members consider aspects about their users that would otherwise not be considered, such as different socio-economic background, ethnicity, gender and so on - aspects that might impact the design when identified. To get a good result, the creation and selection of personas is important, since the character traits of different personas might affect the final design. Therefore, personas should not be chosen at random, but rather be grounded in quantitative and ethnographic data in order to get the most out of them.

### 3.1.10. Interviews

Interviews can be described as a conversation with one or several users, with the purpose of gathering information about their needs and opinions on a certain product or system. There are four main types of interviews: unstructured, structured, semi-structured and group interviews (Sharp et al., 2007). The three former types are all individual interviews named after the amount of control the interviewer apply on the conversation, while the fourth interview type is performed in group with several interviewees at once. Unstructured interviews are exploratory and the questions asked by the interviewer are often open, with the purpose of triggering conversation around particular topics. The interviewer has no real expectation about the format or the content of the answers. Questions are often formed during the interview, as the conversation goes along. In structured interviews on the other hand, most of the questions are predetermined and similar to those in a questionnaire. The questions are often short and closed, requiring answer from a fixed set of alternatives. During structured interviews the same questions are used with every participant, making up a standardized study. Semi-structured interviews combine features of both previous interview types, mixing open and closed questions during the interview. To make sure the same topics are covered in every interview, the interviewer often follow a basic script with preplanned questions, but then probes the interviewee, making them elaborate on their answers.

## 3.2. Structure of the study

As suggested by Jones (1992), a design study can oftentimes be divided into three stages; divergence, transformation and convergence. This project was not an exception, and the structure of the study is therefore presented, divided into the mentioned stages.

### 3.2.1. Divergence

During the divergence stage, the objectives are to gather relevant knowledge about the situation and to deliberately increase uncertainty, in order to get rid of preconceived ideas about how to solve the problem. At this stage, the design objectives are often uncertain and the problem boundary is somewhat undefined.

The first weeks of the project were used to gather information about Wikipedia and its community, and what previous research had been done in the area. Information about data

visualization, especially visualizations of temporal aspects, was obtained. And inspiration was sought in previous projects related to Wikipedia, and in various information visualization sources[14] [15] [16] [17]. One week was also spent browsing through (historical) content on Wikipedia, editing articles, discussing article improvements on Wikipedia's discussion pages, and reading through guidelines and policies[18]. The purpose of these activities was to make sure that the problem area was fully understood, and to get rid of any preconceptions about the solution.

### 3.2.2. Transformation

As necessary background information was obtained, the project moved into the transformation stage. During the transformation stage, the objective is to come up with new, creative solutions to the problem at hand, based on the knowledge gathered during the divergence stage. During the transformation stage, creativity, inspired guesswork and freethinking is highly encourage, in order to come up with as many different design solutions as possible, as described by Jones.

Based on the information gathered during the convergence stage, a number of general objectives were stated, that the design should be able to fulfill. The purpose of this was to provide at least some guidance during the upcoming design work, yet without being too restricting, thus risking to limit the creativity.

At first, a sketch session was conducted in order to get a common visual understanding of the problem and to produce some material for discussion. For the session, a downscaled version of the 6-3-5-method was used (see Appendix A). The objective was to sketch the first things that came to mind, coming up with various design concepts that could be further developed and explored in later on. A second sketch session was also conducted where metaphors, personas and limitations were used to remove some mental blocks and to think somewhat outside the box. After the first sketch session, a KJ-method session was held (see Appendix A), intended as an

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[14] Visualization Magazine: http://visualisationmagazine.com/blogvisualthinkmap/

[15] Infosthetics: http://infosthetics.com/

[16] We Love Datavis: http://datavis.tumblr.com/

[17] Information Is Beautiful: http://www.informationisbeautiful.net/

[18] Policies and guidelines for Wikipedia - http://en.wikipedia.org/wiki/Wikipedia:List_of_policies_and_guidelines

evaluation of all sketches produced so far. The KJ-methods was chosen since it produces a result where similarities can be identified, grouped together and given a label. To further spark creativity, and to make sure that as many design solutions as possible were revealed, a second 6-3-5-method session was held (see Appendix A) together with three fellow interaction designers.

To get additional input to the design work, some of the sketches produced during the early sketch sessions were discussed with Karin Ackerholm at inUse[19], an experienced interaction designer. During a semi-structured interview, Karin was asked to provide insights and feedback on the different solutions created so far. The feedback was then used as input and inspiration in a following round of sketch sessions, in order to generate more ideas and problem solutions.

### 3.2.3. Convergence

During the transformation stage, a large number of possible design solutions were revealed, all with their own pros and cons. As advised by Jones, projects entering the convergence stage should start focusing on reducing the number of design ideas, and thereby moving towards a final design. Therefore, the different design ideas were discussed, leaving only a few to be considered possible candidates for further improvements. These designs were discussed during a second meeting with Karin Ackerholm, and the input from that meeting was used to limit the number of alternative designs even more, leaving only the most promising designs for further improvement during more sketch sessions.

To be able to evaluate and choose one of the designs based on user input, a first round of user tests was conducted (see Appendix A). Six participants were then chosen, each of them being frequent Wikipedia users. The group of participants was chosen to contain three people with medium computer experience, and three people with expert computer experience. Among the more computer-experienced participants, two were interaction designers and one was a programmer. The purpose of the tests was to see if the design was self-explanatory, and if all information was conveyed through the visualization. Data from the first user tests were then

[19] inUse, a digital bureau focusing on interaction design, usability and effect management - www.inUse.se

analyzed during a KJ-method session (see Appendix A), with which the aim was to identify pros and cons for each of the designs, based on the transcripts from the interviews.

During the following design sessions, all aspects revealed in the user tests were taken into account and dealt with, producing one single prototype that could be tested in a second round of user tests before developing it into an interactive prototype. A second user test was hence performed, in order to evaluate the prototype in terms of how easy the new concept was to understand, and what parts of it could be further improved. Since many features in the design were derivatives of features in previous designs, many of them had been tested out earlier. Therefore, it was considered sufficient using only four participants for these user tests - two from the first user tests, and two who had not seen any previous prototypes. The prototype was discussed with the users, in order to see how well they understood it and what they liked and disliked about it.

Based on the input from the user tests, design and development towards an interactive prototype, based on the design concept tested, could commence. As the backbone structure of the interactive prototype was being built, the design was continuously improved throughout iterations of design sketching in Photoshop, discussions about features in the design, followed by re-designing and development of interface components. These iterations continued until the entire interface was formed, as well as the backbone structure, completing the interactive prototype.

To conclude the study, the last weeks were used to evaluate and discuss the knowledge that had been obtained during the design process. The suggested design was also compared and discussed in relation to previous related work, to elucidate differences and similarities between the results of this project and previous studies. Further, the chosen work path and the methods and techniques used in the project were discussed. Possible ways to improve the work process were discussed as well, as it might be of interest to designers addressing similar tasks. Finally, ways to extend the study and to improve the design concept were discussed, and topics for future work were suggested.

# 4. DESIGN PROCESS

In this chapter, the entire design process that lead to a final design is presented. At the beginning of the project, some of objectives were stated, to guide the work throughout the rest of the project. A period of freethinking and creativity then passed, where a large number of possible designs were created and evaluated. Most of the designs were later discarded because of various problems, until three design concepts remained. The three designs were made into non-interactive high fidelity prototypes, which were evaluated through a series of user tests. The three concepts were then combined into a single design, based on the feedback from the user tests. Through a number of iterations, the design was then refined and further tested, until a final design was reached.

## 4.1. Stating objectives

Since there were no clear boundaries for the project in the beginning, there were simply too many different possibilities for what direction to take the design in. This made it difficult to be creative and to come up with interesting design ideas, since no idea could be labeled good or bad when there were no objectives or requirements to use as guidelines. In order to deal with this uncertainty, some general objectives for the project were stated early on, which could serve as a guide indicating what directions might be suitable to explore through design. There were three general objectives stated:

1. The users should be able to determine if an article has been edited many times
2. The users should be able to determine if an article has been edited by many or a few contributors
3. The users should be able to determine if some contributors has contributed more than others to an article

These objectives were all considered important to design for, since they would give the users an idea of how reliable the content of an article was. *First*, by making it possible to see whether an article had been edited many times or just a few, the user would get an insight into the amount of

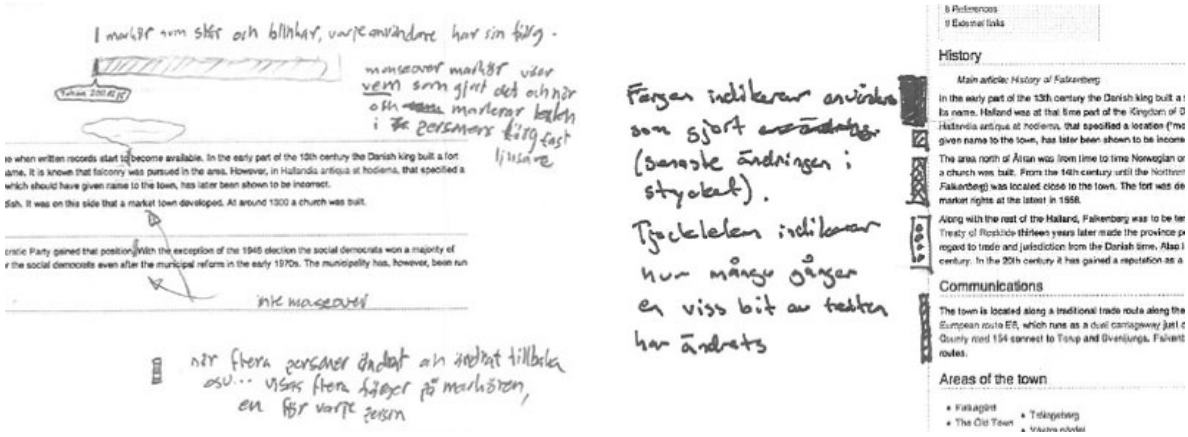
editing activity surrounding the article. This might make it possible to determine whether the article have been revised many times or if it was produced all at once and perhaps never looked at again. *Second*, if the users were able to determine if many or a few contributors had been involved in creating the article, then they would get an idea of whether the article's content were the thoughts of a single individual or common knowledge throughout a large amount of contributors. The greatness of Wikipedia is that people working together can create something not only vast and amazing, but also reliable and even as accurate as the Encyclopedia Britannica (Giles, 2005). For this reason, the amount of people contributing to an article was considered valuable information to whoever was to read it. *Third*, by making it possible to see if some contributors had edited more than others, the users would be able to determine if a certain version of the article was written by someone historically active or by a new contributor to the article who perhaps is not as grounded in the subject.

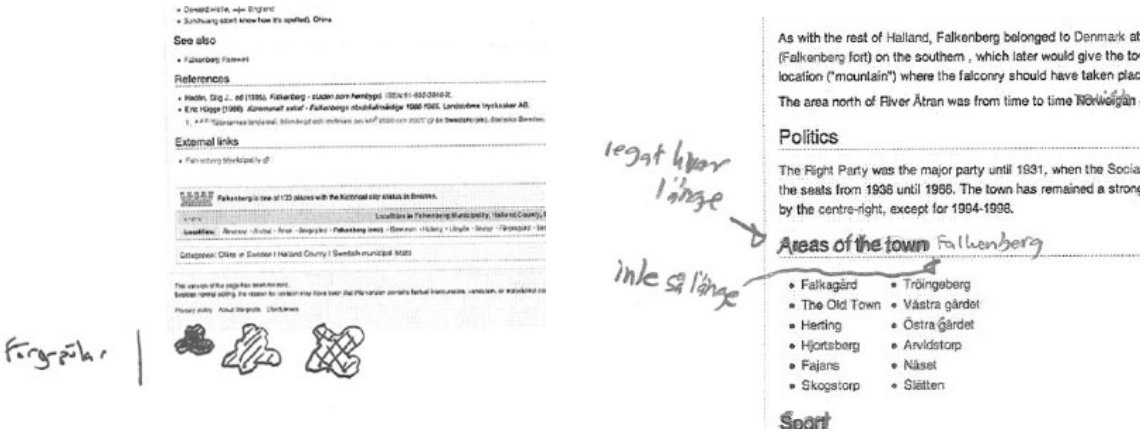
## 4.2. First design approach

In the early stages of the project, the design sketching was heavily affected by an idea of making history "shine through" the live version of an article. The idea was to find various ways of letting the content of previous versions leave traces in the live version, somewhat like how stains of coffee in a book could leave traces of whoever was reading it, for future readers to see. This way of looking at an article as a permanent object, impacted over time by users editing its content, took the design sketching in a more artistic direction. Little or no thought was paid to making the design useful and easy to understand, at least in the beginning. The goal was simply to come up with creative ways of letting history impact the present - the more history, the larger impact - and then, later on, try to make the concept practical and easy to use.

Through many sketch sessions, using methods such as a modified version of 635-method, inspiration search in information visualization literature and so on, a large amount of sketches and mockups were developed (figure 4.1). The main goal with these sketch sessions was to try out different ideas and to inspire new and fresh thinking about the design. One design concept explored during this time was based on the metaphor of erasing text on a piece of paper. When using an eraser, some of the written text is often (faintly) visible even when it has been "erased", making it possible to see the text underneath whatever is written afterwards. Applying this

metaphor to Wikipedia articles resulted in an idea of letting each new version of an article be placed on top of the previous versions. As more and more versions were created, the oldest versions would be fainter and fainter until the type color of the text in these versions was almost white and not recognizable. A similar idea was to make text that had been around for many versions be displayed in a darker color, in the live version. Newer text would then be displayed in a light gray color, indicating it was recently written. Another idea was to make text wobble for a while when it was created, and as time went by it would start wobbling with a lower and lower frequency, thereby making new content more eye-catching than older content.



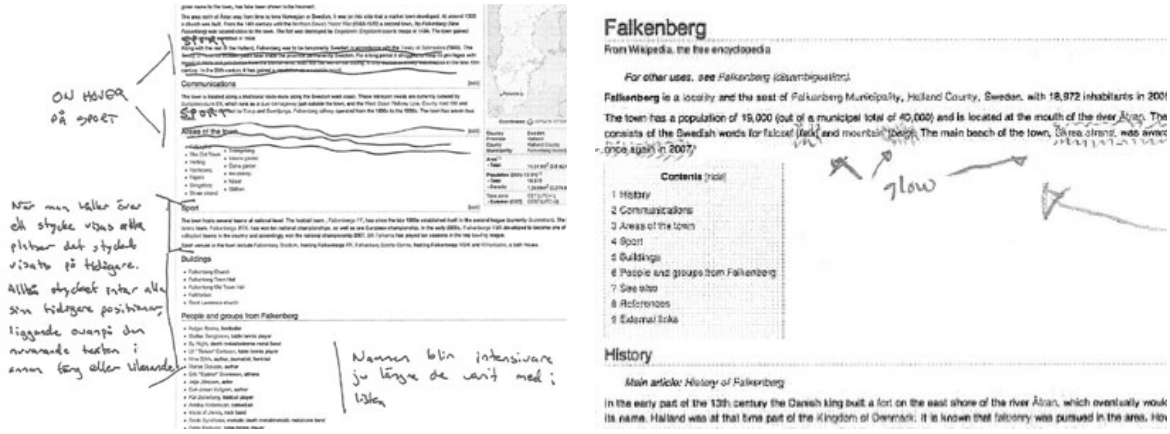



**Figure 4.1** - Some early sketches and mockups.

The sketches created so far were then evaluated during a KJ-method session (figure 4.2), where all ideas were structured into groups based on what the different designs depicted. Some designs made visible *what content* had changed in an article, others *how much* the content had changed, still others showed which users had *contributed*, and another which users *contributed the most.* The main conclusion from the KJ-method session was that the concepts explored so far dealt with a lot of different aspects that did not fulfill all of the main objectives one by one.

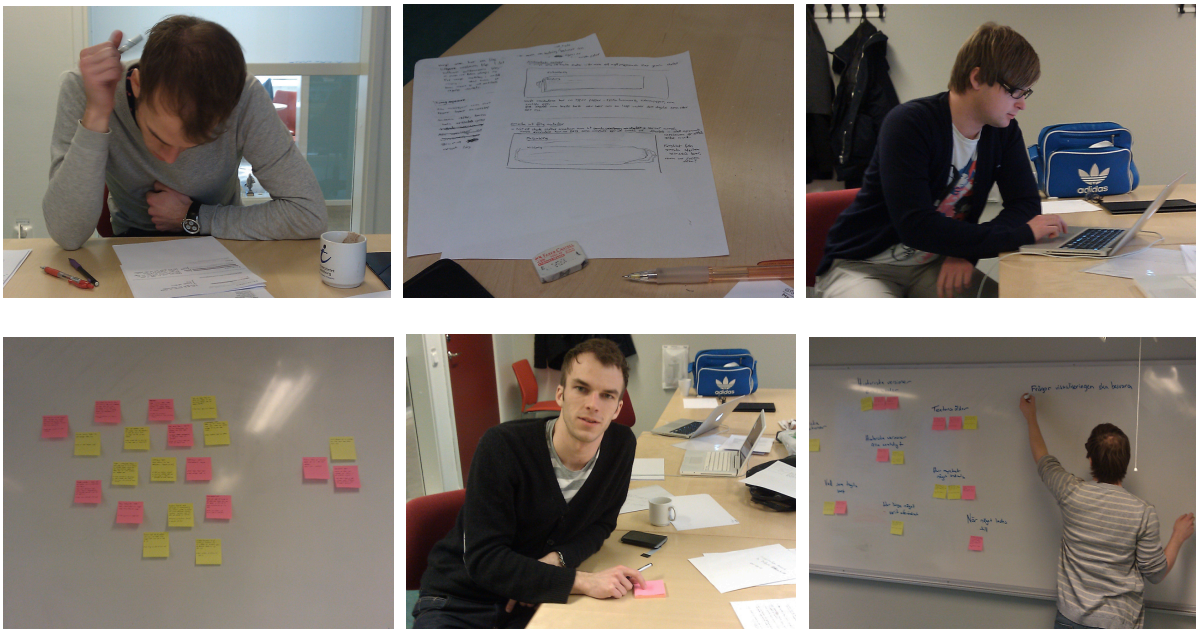


**Figure 4.2** - Photo collage from the KJ-method session

To come up with new design ideas, that would better reach the objectives, several different activities were performed, such as coming up with various metaphors for historical usage leaving traces on an object. Another activity was that of a modified 6-3-5-workshop with three interaction designers and the two authors, where a few new design sketches were developed, exploring some new ideas. Some of the sketches developed during these activities can be seen in figure 4.3-4.5. The ideas included that of using a paper pile metaphor (figure 4.3), placing a new paper on top of the pile for each new version being created. Another idea (figure 4.4) was to have the old content of a section of an article be pushed tightly together in the top of each section, almost like when weaving a carpet. A third design idea (figure 4.5) was to have old versions of the article stored in a pile at the bottom of the article, kind of like the rolled out paper on a toilet paper roll would lay when it was rolled out on the floor. Most of these ideas were useful for triggering creative thinking, and to explore different design directions for the study, but few of them fulfilled all objectives and a lot of them were simply dead ends. However, some of the sketches - as describe below - were found suitable for further improvement and more exploration, and were therefore kept.


**Figure 4.3** - Each version of the article represented by a piece of paper. The papers are then stored on top of each other as new versions are made.

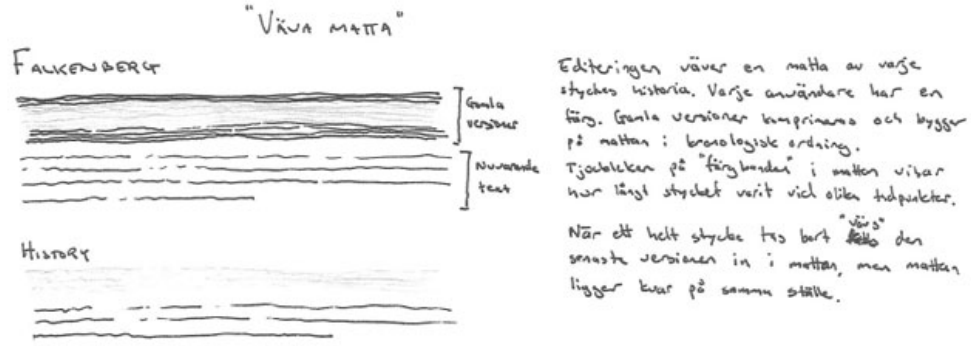



**Figure 4.4** - Old versions of a section of an article is woven into a pattern placed on top of the section.

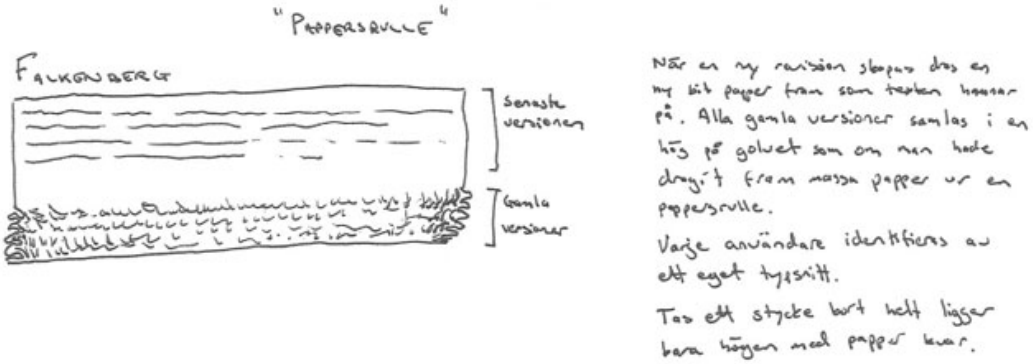



**Figure 4.5** - Papers stacked in pile at the bottom of a section, almost like how toilet paper falls onto the floor when rolled out.

Out of all rough sketches produced so far, three designs were somewhat improved, as seen in figure 4.6, 4.7 and 4.8. In *figure 4.6*, the text of old versions were colored based on what contributor wrote the versions and then squished into a compact mode and placed underneath each section headline, somewhat like weaving a carpet. In *figure 4.7*, footprints were used to indicate what content in an article was created by what contributor. Each contributor was given a unique footprint, and the footprints were then placed on top of the sentences written by that user. Finally, in *figure 4.8*, the history of each section of an article was dealt with separately, based on a paper pile metaphor. In this design, every time a contributor made a change to a section of an article, a new paper would be placed on top of that section. When a section had undergone extensive editing, lots of papers would be placed on top of each other. To differentiate versions

made by different contributors, each paper would be colored in the bottom and right margins based on a color assigned to that specific contributor.

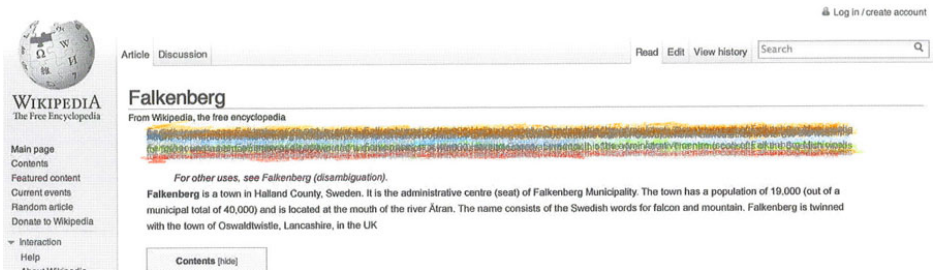



**Figure 4.6** - Prototype where old versions are colored based on the author and squished together below the headline, like weaving a carpet.

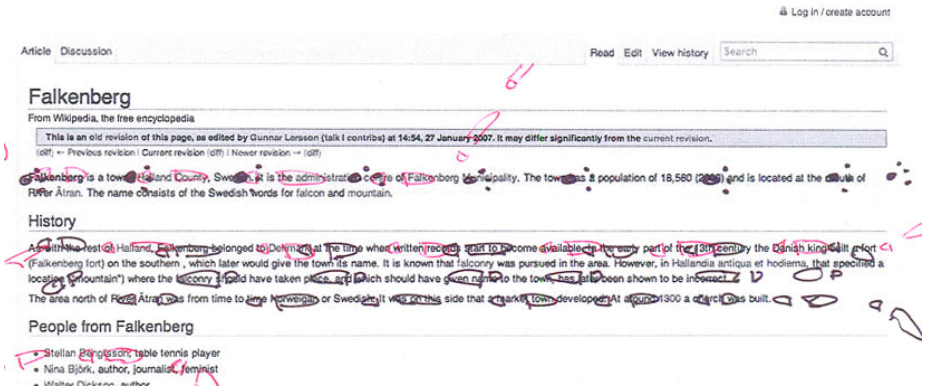



**Figure 4.7** - Prototype where footprints were used to indicate who contributed to the content.


**Figure 4.8** - Prototype where every new version of a section was placed as a piece of paper on top of the previous version, creating a paper pile.

## 4.3. Re-focusing the project

After having discussed and evaluated the three low-fi prototypes (seen in figure 4.6-4.8) in an interview with Karin Ackerholm, an experienced interaction designer, it became obvious that the first approach had too extensively been focusing on letting history leave traces in Wikipedia articles. When taking an interaction design perspective, instead of a more artistic one, it was not obvious that letting history leave traces in the article was the most useful way to visualize article history. The design ideas did simply not derive from actual user requirements, but rather stemmed from initial ideas of the authors. To take a proper interaction design approach to the challenge, the project was somewhat re-focused. Instead of focusing on *how* history can leave traces in an article, *what* information to visualize and *why* became the center of attention. To be able to base the design on user requirements, the first step was to define a set potential user types and their individual needs.

### 4.3.1. Identifying the users

The first step in re-focusing the project was to determine which types of Wikipedia users that could make use of the article history, and what they could use it for. Three type of users were identifed, who all use Wikipedia with somewhat different purposes. The first user was “The one focused on a topic”, who is looking for knowledge about a given topic, not looking for answers to a specific question. The second user type was “The answer seeker”, who has a specific question for which to find the answer. The third, and last user type was “The editor”, who browses Wikipedia with the purpose of finding articles to improve by editing.

Based on the objectives stated earlier in the process and on the requirements held by the three user types, four main requirements emerged.

1. The user should be able to determine if an article has been edited by many.
2. The user should be able to determine if an article has been edited many times recently.
3. The user should be able to determine if an article has been edited many times overall.
4. The user should be able to see previous versions of an article.

The first three requirements corresponds to the objectives stated earlier and were therefore considered top priority. The forth requirement stemmed from both “The one focused on a topic” and “The editor”, but the feature was only considered nice-to-have, and therefore did not get the same priority as the previous three. The four requirements were to be the starting-point for the new design process, as the project was re-focused.

### 4.3.2. Focusing on entire sections

During the first sketch sessions, no decision had been made regarding what should be considered a change in the article content. Some sketches focused on changes in individual sentences, others looked at entire sections or even the entire article. Looking at changes in individual sentences was problematic since it was difficult to determine what was a changed sentence and what to be considered a new sentence. Also, determining who was the contributor of a changed sentence was difficult since it could be both the person first writing it or someone editing massively it later on. Instead, a focus was placed on changes to sections of subtopics in an article, where a section was defined as all content under a second level headline. If some content changed, even on a character basis, that entire section was considered to have changed. It would have been possible to consider change on an article level, simply visualizing every revision of the article. An article however is often divided into subtopics, where some subtopics are changed more than others. Visualizing changes on a subtopic level could therefore be useful, by providing historical information on a more detailed level.

### 4.3.3. Five paper mockups

To generate new design ideas, a combination of methods was used. Using extreme characters, personas and limitations, five design concepts were generated and presented as paper mockups.

Among these five, three concepts were later chosen to proceed with, and two were discarded because they were unnecessarily complex, without adding any additional information.

#### The Paper Pile

The first concept was based on an idea that every new version of a section adds a new piece of paper to a pile containing all previous versions of that section. In the first state (figure 4.9), paper tabs were added to the right side of the article, to provide a visual clue to the section history. By

hovering the mouse pointer over the tabs (figure 4.10), some extra information was revealed as a tooltip.

When clicking the paper tabs, the section content was pushed aside, making room for the section history (figure 4.11). Every version was still represented as a paper in a pile, and to every paper a small colored ribbon was attached. The color was used to indicate what user created that specific version. Below the pile of papers, two bars were available. The top bar was to be used when a section had more versions than what is possible to display in one screen. The bar was split into parts, each part representing a fixed number of versions, and by clicking a part, the paper tabs for that part was displayed. The second bar displayed all contributors to the section. Every contributor was represented by a colored part of the bar, with the width of the part based on the number of contributions by that user.

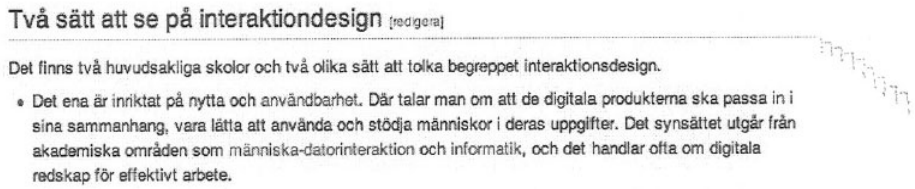



**Figure 4.9** - Paper pile, first state where no interaction has taken part


**Figure 4.10** - Paper pile, second state, when user is hovering cursor over papers.

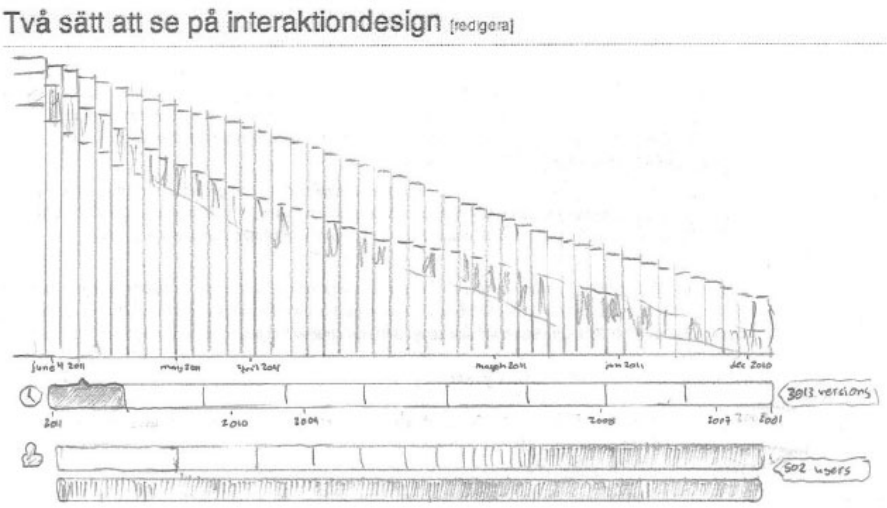



**Figure 4.11** - Paper pile, third state, when historical versions are being displayed.

## The Zoomed Timeline

The second concept was based on a timeline, where each version of the section was represented as a colored stripe, with the color representing the creator of that version. In the default state, the timeline was inserted below the section content, as a visual clue to the section history (Figure 4.12).

By clicking the timeline, the full section history was revealed. The idea was to add zooming to the timeline, as each version only was presented as a one pixel wide stripe on the timeline. The zoomed-in section was displayed above the time line (figure 4.13), and a small square on top of the timeline indicated what part of the timeline that currently was in focus. In the zoomed-in view, each version was presented as a tab, with a colored ribbon at the top indicating the contributor of that version. To navigate through the section history, the users would drag the square on the timeline to move the zoom to another part of the timeline. In this design, it was also possible to view the content of a previous version by clicking on that versions tab in the zoomed-in view.

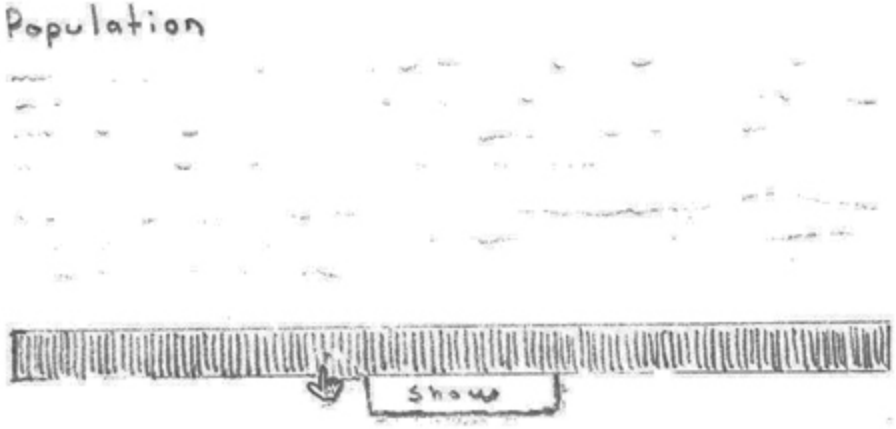



**Figure 4.12** - The default state, showing the timeline below the section content.

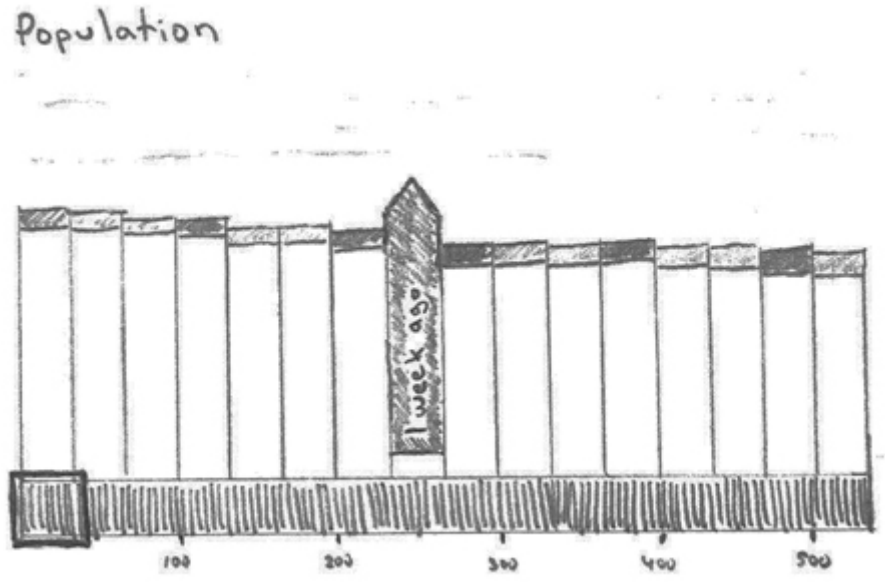



**Figure 4.13** - Showing a zoomed-in view of the timeline that is marked with a square. Each tab represents a version of the section, and the arrow indicate what version is currently being displayed.

## The Bulletin Board

As the name suggests, this design concept was based on a bulletin board metaphor. In the upper right corner of each section, a pin and a perforation provided a visual clue the current version could be removed to reveal what's behind it (figure 4.14). By clicking the pin and perforation, the content of the current version was removed and traces of previous versions became available. Each previous version was represented by a pin, placed somewhere on the surface where the section content previously was (figure 4.15). A decay to the pins indicated how old that version was. By hovering a pin, a tool tip was displayed providing information about who created that version and when. Then, below all the pins, a regulator made it possible for the user to go back in time (figure 4.15). By moving the regulator to the right, more recently added pins fell of the bulletin board, and older pins became more visible.

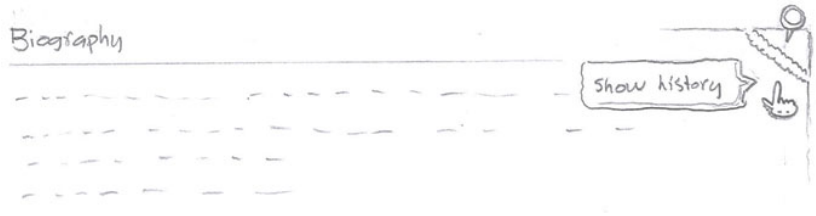



**Figure 4.14** - Tooltip displayed when hovering cursor over top right corner, about historical content being accessible.

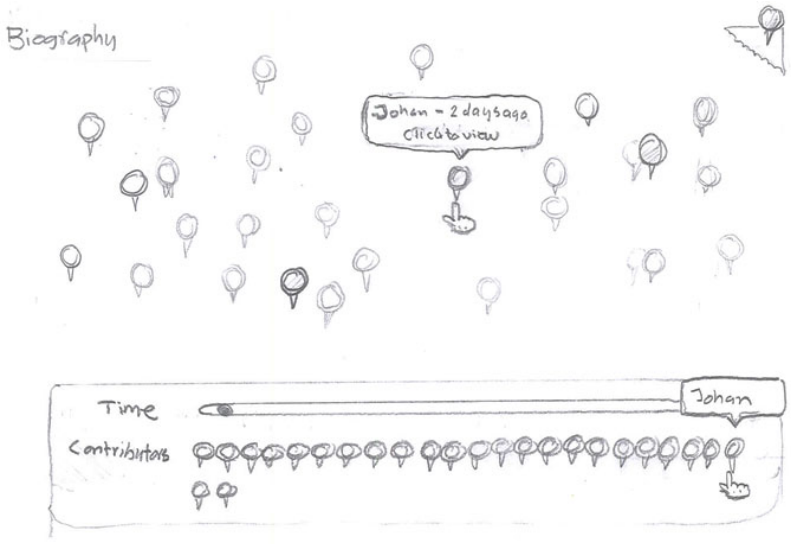



**Figure 4.15** - Pins representing previous versions of the section, in this case of the 'Biography'-section of an article.

## Circles and Squares

This design concept was based on an idea to let circles represent contributors and squares represent versions. In the default state, squares and circles were added to the right of the article. This gave a rough estimation of the number of versions and the number of contributors to the section (figure 4.16). To reveal the full section history, the user clicked somewhere on the circles and squares. This would display extra information below the section content (figure 4.17). The diameter of the circles now indicated the number of edits by that contributor. The circles were aligned in descending order based on the number of contributions. The squares (representing versions) were all aligned in descending chronological order. Between the circles and the squares, there was a regulator, allowing users to move backwards in time to display previous versions. It was also possible to hover a square to highlight the author of that version, and to hover a circle, highlighting all versions by that contributor.


**Figure 4.16** - the default state, where circles represent contributors and squares represent versions of the section.

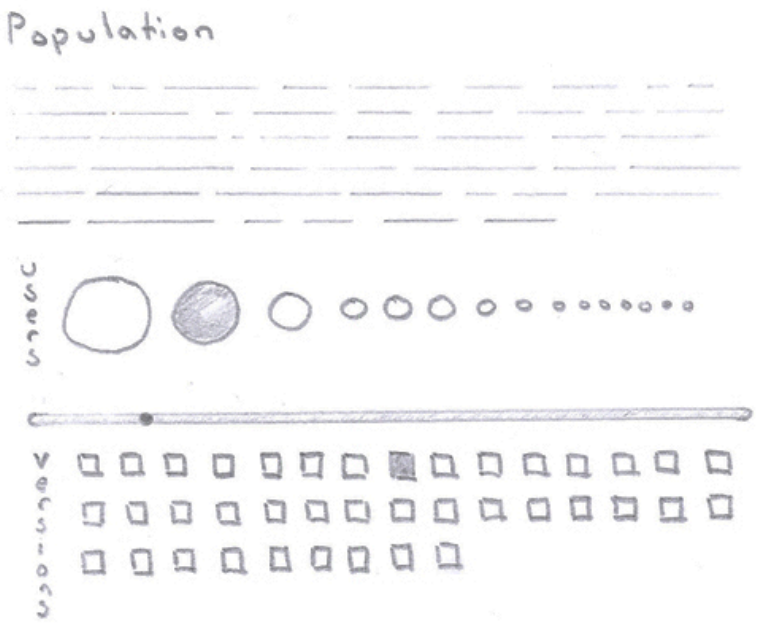



Figure 4.17 - Each contributor is represented by a circle, where the diameter indicates the number of contributions. Each square represent a version of the section, arranged in reverse chronological order.

## The Time Filter

The last of the five concepts was visible to user as a small tab that was added to the right of the section headline. By clicking the tab, the user revealed the complete section history (figure 4.18). The visualization of the section history was built around two main components, a time filter regulator and a box where the versions were shown. By default the filter was set to display all versions of the section, but by moving and resizing the regulator, the user was able to set a custom time span to focus on. When such a custom filter was applied, the box containing all versions was filtered down to only contain versions created during the chosen time span. Each version was represented with a small box, containing information about the age of that version. In the lower-right corner of the box, a colored user icon indicated who created that specific version. By clicking on a version, the user was able to see the section content as it was in the version.

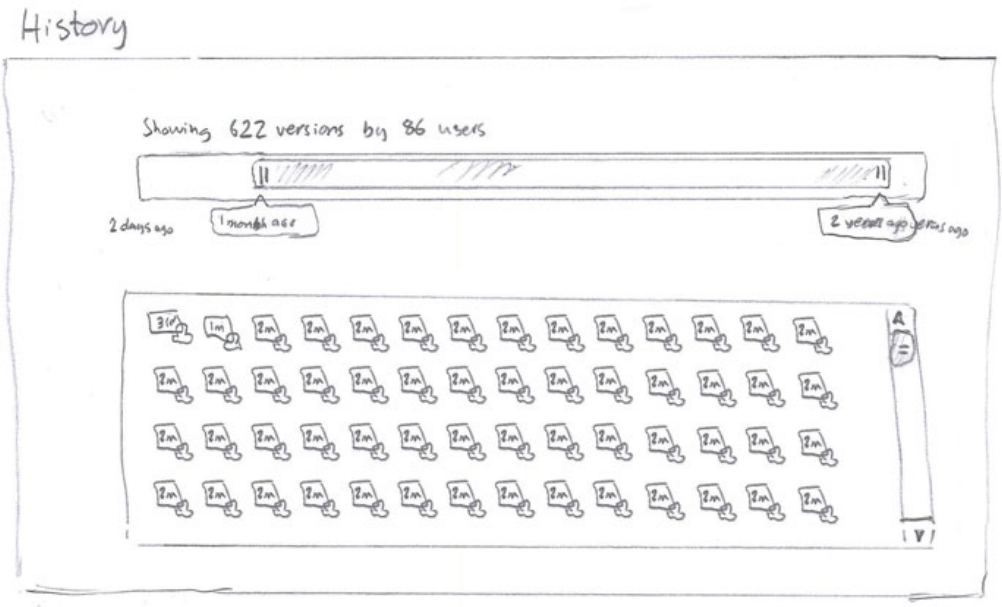



**Figure 4.18** - View displayed when user has chosen to see the history of a section. Depicting a time filter and all versions from a given time interval

### 4.3.4. Five becomes three

Evaluating the five designs resulted in that three designs were chosen to proceed with. The three designs, describe below, were then further improved and turned into non-interactive, high fidelity prototypes. The prototypes were later used during a first round of user tests, to further evaluate what design to proceed with (see part 4.3.5 about evaluating the prototypes).

#### The Paper Pile prototype

This prototype was based on the paper pile design described in 4.3.3. In the initial state, before any interaction has taken place, small and discrete paper tabs were added to the right side of each section (figure 4.19). The paper tabs, all representing a version of the section, gave a first rough estimation about whether there were many or few version of the section, and also provided a visual clue about the existence of section history. When the user hovered the mouse cursor over the paper tabs, the content of the section was somewhat squeezed together, revealing more tabs and extra information (figure 4.20). On each tab, a colored ribbon appeared, each color unique for each contributor. Also, above the paper tabs, a tool tip displayed information about the total number of versions and contributors to that section. Clicking the paper tabs revealed the full section history (figure 4.21). The first tab to the left, somewhat different from the others,

represented the current version of the section. The age of each version was also written vertically on each tab and a scrollbar made it possible for the users to browse through the historical versions.

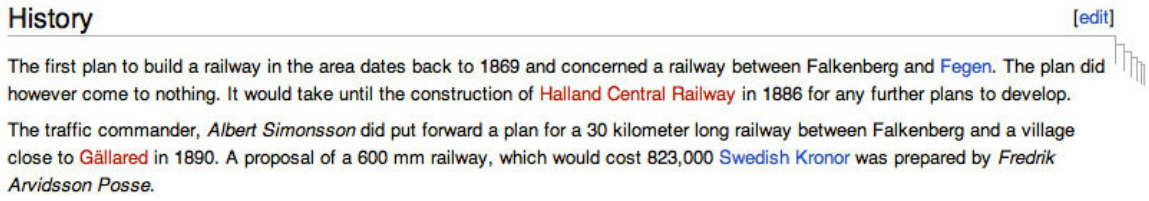



**Figure 4.19** - Small paper tabs in the right margin gave a first rough estimation of the number of versions.

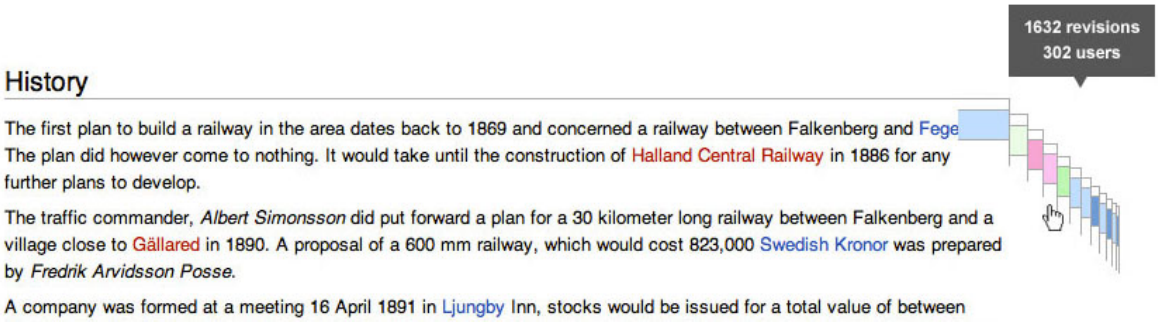



**Figure 4.20** - When hovered, the paper tabs slid aside revealing extra information.

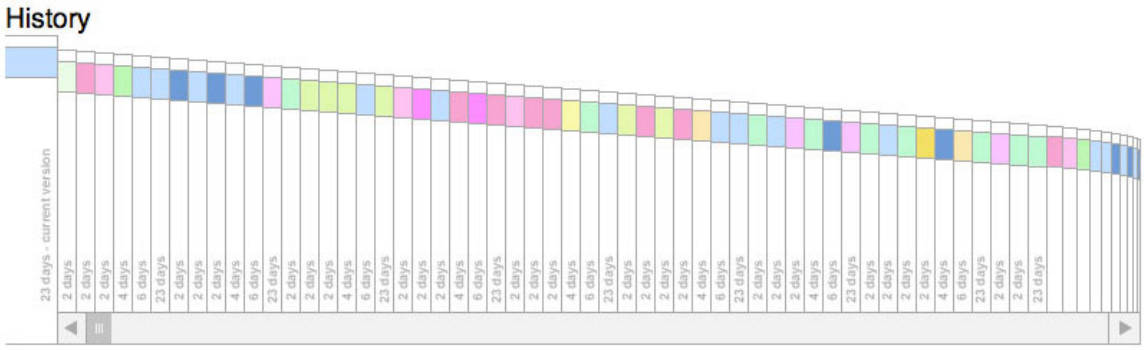



**Figure 4.21** - Full section history, where each version is represented by a paper tab.

## The Zoomed Timeline prototype

This prototype was based on the zoomed timeline design (described in 4.3.3), where each version of a section was indicated by a stripe on a timeline. Timeline was placed below the content of each section (figure 4.22) and colored in gray shades to not be dominant in the interface. The more versions of a section, the smaller the stripes on the time line, providing users a first rough estimation about whether the section had many or few previous versions. Hovering the timeline with the mouse cursor, the stripes on the timeline would be colored, each color representing the creator of the version represented by the stripe (figure 4.23). Thereby giving users an overview of contributors to the section. When clicked, the timeline would slide down, making room for a magnified view above it, displaying a selected part of the timeline in greater detail (figure 4.24). The part currently focused on was marked with a small gray square that could be dragged in order to navigate through previous versions. In the detailed view, above the time line, each version was represented by a bar, with a colored ribbon at the top. The color indicated who created that version, and corresponded to color of the stripes on the timeline. The height of the bar indicated the age of that version, with older versions being shorter than the more recent ones. Each bar was clickable, replacing the content displayed with the content of the clicked version. The colored bar, with an arrow at the top, indicated what version was currently being displayed.

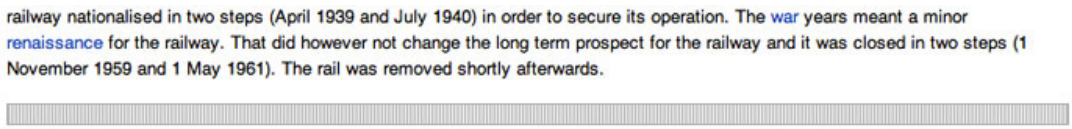



**Figure 4.22** - Timeline with previous versions represented by a thin stripe.


**Figure 4.23** - Hovering the timeline colors the stripes. Each color represents one contributor.

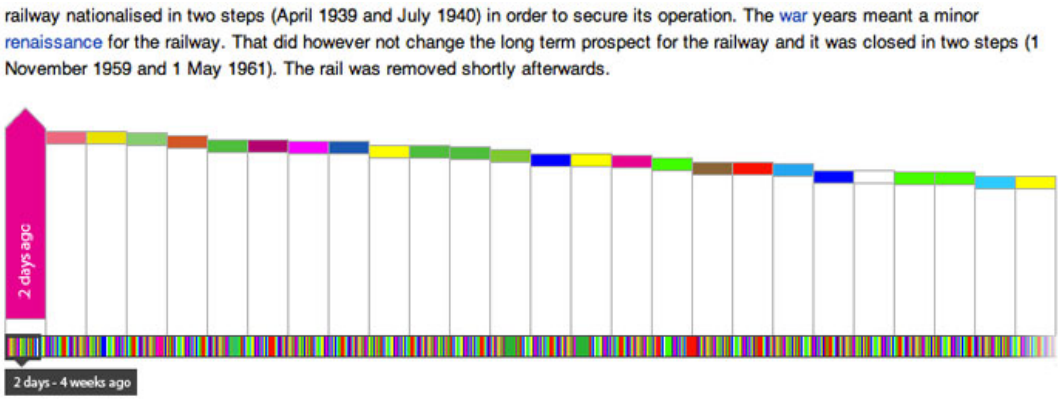



**Figure 4.24** - Magnified view of the left most versions of the timeline. Each white bar is one version of the section of the article. The pink arrow indicates the text displayed above belongs to that version (that bar).

## The Time Filter prototype

This prototype was based on the time filter design (described in 4.3.3), where a time filter was used to filter the historical content, to show versions from a given time frame. In the first state, a small text was added to right of the section headline, stating the total number of versions of that section (figure 4.25). A small arrow to the right of the text served as a visual clue to indicate that more information could be expanded. When hovering the mouse cursor over the text, a thin border appeared around it, which made it look more like a button or a tab, making it more affordable to click (figure 4.26). Clicking the tab would reveal the full section history, showing a time filter regulator and an area containing the versions of the section (figure 4.27). The blue bar inside the timeline indicated what time frame was currently selected, and it could be resized to filter out versions of a given time frame. Tool tips at the beginning and at the end of the blue bar provided information about the range of the currently selected time frame. A text above the timeline provided information about how many versions were created during the selected time frame, and by how many contributors. In the box below the timeline, all versions created during the selected time frame were displayed as small squares. Each square represented a version and the age of each version was added as an abbreviation inside the square, “1h” referring to one hour, “2d” referring to two days, and so forth. Further, information about who created the version was added as a colored user icon in the bottom-right corner of the square. The color of the user icon was unique to each individual contributor.

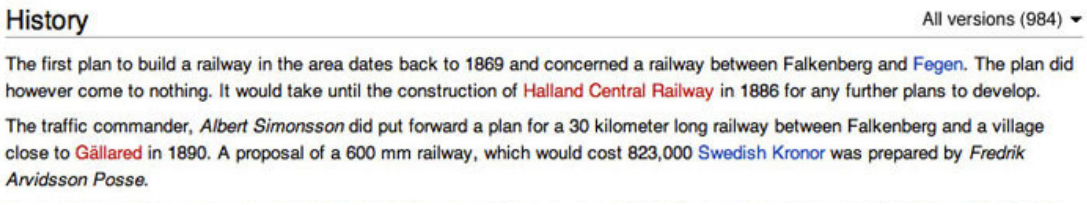



**Figure 4.25** - The default state, where the number of version was shown in the upper-right corner.


**Figure 4.26** - When the number of versions was hovered, a small border was added to make it more affordable to click.

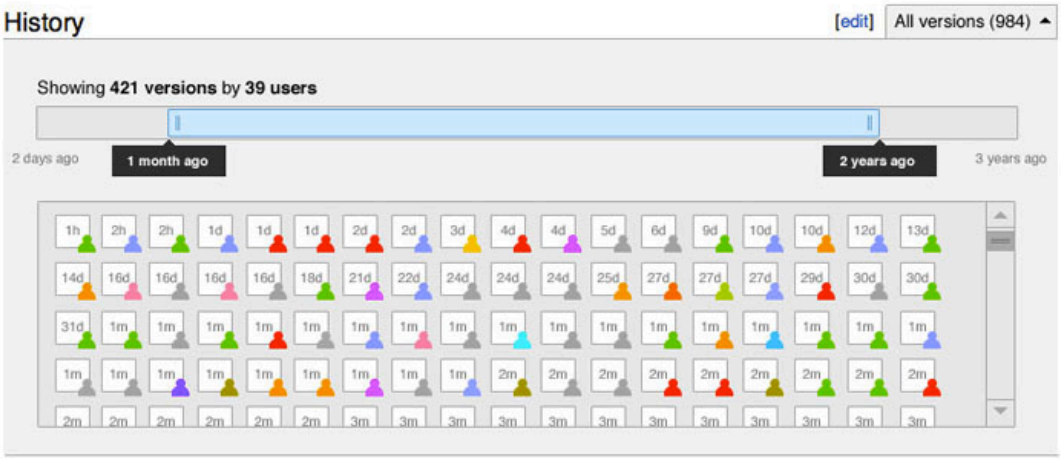



**Figure 4.27** - Section history where a time filter was used to display only versions from a customizable time frame.

### 4.3.5. First user tests: Evaluating the three prototypes

In order to conduct a good evaluation of the three prototypes, a series of user tests were performed. These tests were intended to make visible the pros and cons of each prototype, and thereby making it easier to choose which prototype to base the future design upon, and also which features to keep and which to discard. Six Wikipedia users participated in the tests, three of them considered them selves having medium computer experience and three of them were chosen since they could be considered having expert computer experience (all having studied IT). The tests were performed with the users one by one in sessions about 45 minutes long, using a laptop to display the three prototypes described in 4.3.4. All users were shown all three prototypes, but in different order, so that all prototypes were shown first, second and third two times each, as seen in table 4.1.

| | Gender | Computer experience | Paper Pile prototype | Zoomed Timeline prototype | Time Filter prototype |
|---|---|---|---|---|---|
| **User1** | Female | Medium | 1 | 2 | 3 |
| **User2** | Female | Medium | 2 | 3 | 1 |
| **User3** | Male | Medium | 3 | 1 | 2 |
| **User4** | Male | Expert | 2 | 1 | 3 |
| **User5** | Female | Expert | 3 | 2 | 1 |
| **User6** | Male | Expert | 1 | 3 | 2 |

**Table 4.1** - Participants in the first user tests, and the order in which sketches were shown

#### The Paper Pile prototype

The Paper Pile prototype (figure 4.21) was found having the easiest to understand metaphor, with each version of a section in the article displayed as a new sheet of paper, placed on top of the other versions. Having seen the two other prototypes previous to this one, User5 said that this prototype felt the most natural, and that it was more like looking at real things than hard-to-understand graphical elements. User3, who also saw the Paper Pile prototype last of the three prototypes said:

*"There is not really anything unclear about this, it is pretty clear. If I had seen this one first I might have wondered what the colors meant, but other than that it was clear."*

User6, who saw this prototype first, did not find it easy to understand that the history could be displayed in the first state (figure 4.28), something that User5 also had difficulties understanding. However, when shown how the historical information could be accessed, User6 had no trouble understanding the concept. Using the scroll-bar to access previous versions, other than the ones that were visible in the interface, seemed easy to understand. One user, User2, said that she thought the versions in the far right (figure 4.29:B), which were less wide than the others, were a good indicator of more versions, being accessible further away.

One user, User6, had some problems interpreting the timestamps on each version (figure 4.29:A), and he was confused about whether the time displayed was the time that had passed between the version and the previous one, or if the time displayed was the age of the version. This confusion was probably (for the most part) a result of the timestamps not being chronologically ordered because of a design error. However, User6 still, after being informed about the error, requested that the temporal information would be displayed in a standard date format telling users more specifically when a version was created (year, month, day). This would, according to User6, make it easier to quickly find a version from a certain point in time, since one would not have to count backwards to figure out how long a go the interesting date was.

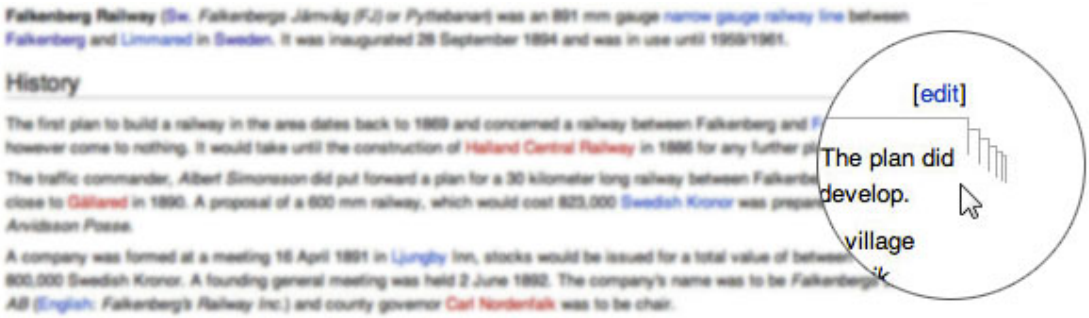



**Figure 4.28** - First state, paper tabs indicating there is historical content to display.

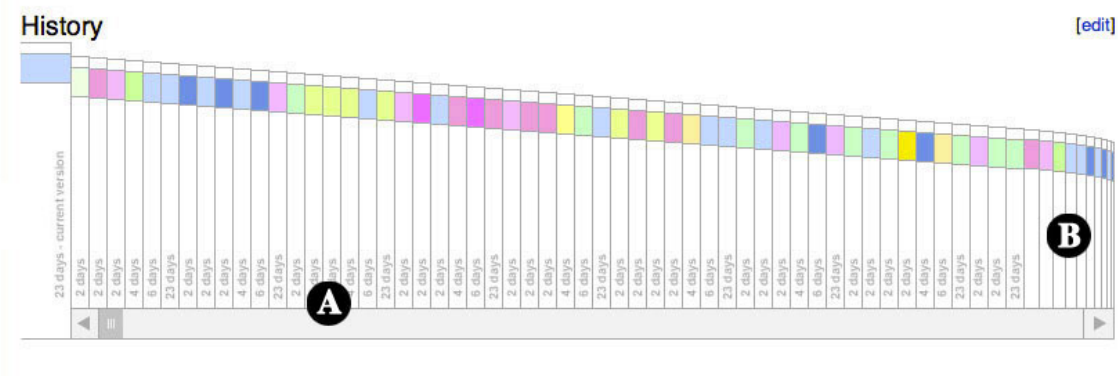



**Figure 4.29**
A - Timestamps on each version.
B - Smaller versions on the right, indicating that more versions are available when scrolling.

The thing most users had a hard time understanding was what the colors of the ribbons on each paper represented. The meaning of the colors was something that confused all users about all three prototypes, and was not specific to this prototype. User6 thought that the colors indicated some kind of approval or disapproval of a user or a version. Almost all users also expressed concern about the colors being hard to distinguish from each other when there would be many contributors to a single section. Some users also mentioned that they liked the discrete colors in the Paper Pile prototype, but they also said that it might be hard to stick to only using discrete colors when there would be a vast amount of users to represent, as expressed by User2:

> *"If we have 200 contributors, would you be able to differentiate between the contributors then.. when you only have these discrete colors [to choose from]? Wouldn't it be a rainbow [of colors] then?"*

## The Zoomed Timeline prototype

In several of the tests, this concept was found the most difficult to understand, and it was only User5 who understood most of concept without given any prior explanation. User2 was very confused about the overall concept, and both she and User3 thought that the tabs (figure 4.31:B) represented a period of time, and that the colored top of the tabs indicated what contributor was the most active in that time period (incorrect).

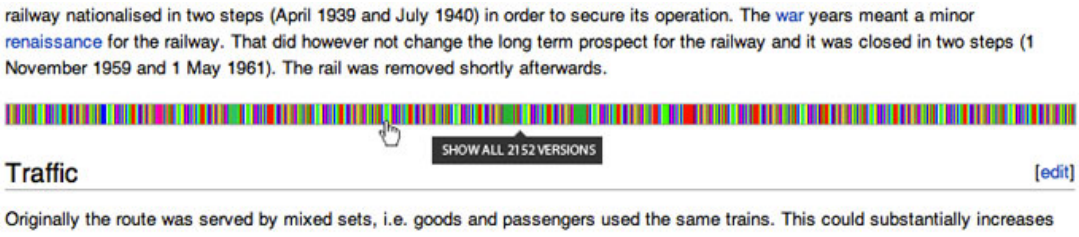



**Figure 4.30** - Timeline with old versions of a section

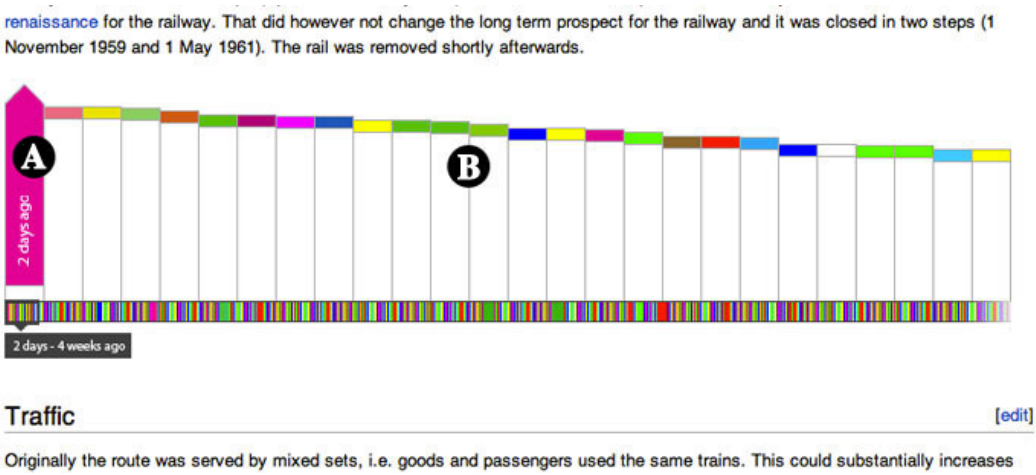



**Figure 4.31**
A - Pointing arrow on the version being displayed
B - Tabs representing old versions, height indicating their age

The bar showing all versions of the section in a compact manner (figure 4.30) was considered practical by some of the users, mostly because of the overview it provided, as User3 notes:

> *"Here, you get an instant overview over everything, which you do not get in the previous one [the Paper Pile prototype]"*

However, all but two of the users (User6 and User4) had a hard time understanding the bar, and they only mentioned that they liked the overview it provided *after* having the bar described to them. User2 did not recognize the gray square that was framing some of the versions in the left part of the bar, and she had problems understanding the connection between the bar and the tabs:

> *"Since the colors are so small on the bottom axis [the bar], it is not obvious that they are the same colors that you see on the zoomed in axis above [the tabs]. Therefore you do not realize that they are coupled together somehow."*

As with the other prototypes, the colors in this one were also a source of confusion. User3, who saw this prototype before any other, thought that the colors were used only do distinguish different tabs from one another. User6, who had seen the two other prototypes before, was not as confused about what the colors represented. He was, however, not very fond of them as he thought they were too visually distinct to blend well into the Wikipedia interface:

> *"It looks like one big orgy in color on the line [the bar] in the bottom... kind of like when you're doing a disc defrag in Windows.. or like some kind of bar code. I don't think it [the bar] adds that much value right now. When there are many versions, the lines will be tiny and the colors hard to distinguish from each other."*

The overall confusion about how to interpret the prototype was perhaps best expressed by User2, who said:

> *"There is so many things.. there is a line in a thousand colors, then an arrow in one color on which it says 'two days' and then it says 'two days to four weeks' [below the bar]. Then the colors just goes on, and there is also different heights [of the tabs]. I don't understand it, I'm only guessing."*

A feature in the prototype that many of the users liked, however, was the ability to see the content of a section while browsing the sections' history – a feature many users lacked in the Paper Pile prototype. Also, many users liked the arrow on the tabs, indicating what version is being displayed by pointing to the text above (figure 4.31:A), as mentioned by User5:

> *"I like that the [representation of the] version being displayed is pointing to the text above, so that one understands that it is the version that is shown right now."*

### The Time Filter prototype

This concept was not found being the easiest to understand, however, some features in the concept were well received by the users in the tests. Some of the users mentioned that the information displayed before choosing to browse the sections history (figure 4.32:A) was more useful, and easier to understand in this prototype than in the other two. User6 liked the information about how many total versions there were of each section, but he lacked some information about how many contributors those versions were written by. For this prototype, user1 found it much easier to understand that the historical versions belonged to the section they were placed underneath:

> *"It is much clearer when you see this [prototype], that you have clicked to show all versions only for this section"*

The time filter (figure 4.32:B), used to limit the amount of versions being displayed in the interface was liked by some users and found complicated by others. User5, an expert user, found the filter useful because she could limit the time of where to look for versions herself, and thereby not having to scroll back and fourth through all versions. Some of the medium experienced users (User1 and User2) did not seem to have an as easy time understanding how to use the time filter. Perhaps these users were not as accustom to this kind of input devices as the more experienced users. User2 did not like the time filter because of her problems with understanding how to use it:

> *"This thing that you drag [the time filter] is the most unclear [element]. Maybe it was only unclear to me, but I was really confused about it. It is difficult to know what to do with it."*

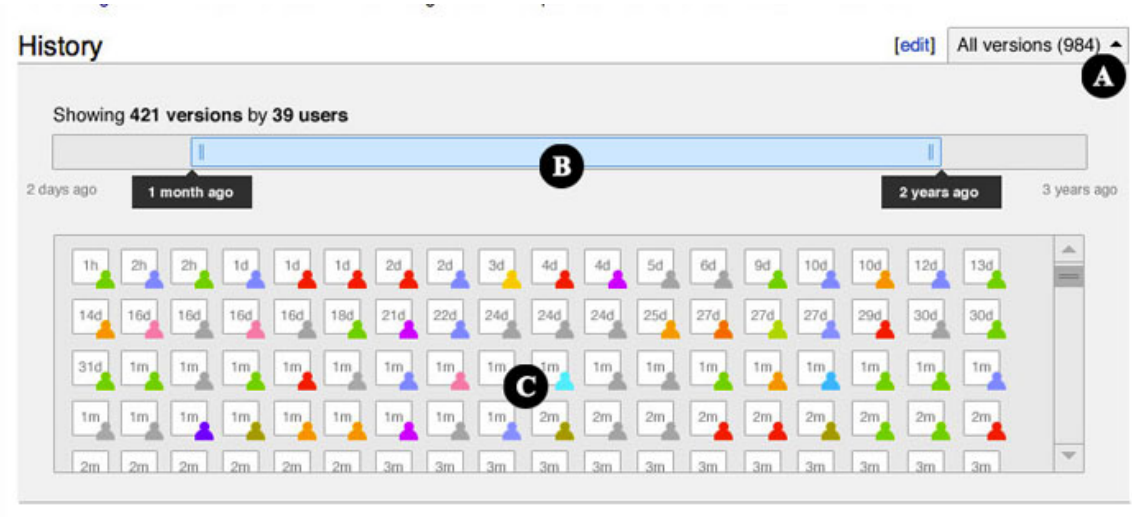



**Figure 4.32**
A - Information displayed before any interaction has taken part
B - Time filter for filtering old versions
C - Colored contributor icons and timestamps on old versions

As with the other two prototypes, the colors in this prototype as seen on the contributor icons (figure 4.32:C) were confusing to the users. Both users 2 and 5, who saw this prototype first, tried to make sense of the coloring but had a hard time doing that. User3 said that she tried to find some kind of logic in the coloring, but gave up when she could not figure it out. User5 thought that the colors might have something to do with versions being approved or disapproved:

> *"The red colors [of the user icons] confuses me quite a lot since red often means 'warning'. When I see the red [contributors] I think that maybe I don't want to see their versions.. or something like that."*

When told that the colors indicated what contributor wrote what version, User5 said that she would prefer to see some kind of legend in the interface, describing the colors. User3 also mentioned that he was trying to find some logic in the colors without making sense of it, and he also requested some kind of explanation of the meaning of the colors. However, when the participants at the end of the test were asked what they thought was good about this prototype, three users (User1, User3 and User4) said that the colored contributor icons made more sense than the colors used in other prototypes, since they were connected to an icon.

The timestamps on the representations of each version (figure 4.32:C) also seemed somewhat confusing, and several users did not understand them. User2 thought the number indicated how many times a certain user had edited the article, but had obvious problems making out what the 'm' (short for 'months') meant. Moreover, the timestamps were quite unspecific since a version being 32 days old would receive the same timestamp as one being 59 days old (1M), as noted by User3.

A general concern, that could be applicable to all three prototypes, came up during the test with User3, who was wondering what the "View history"-link in the default Wikipedia interface (figure 4.33) meant. This link leads to a page where a list of all edits to the article was displayed. It has nothing to do with our prototype, but could obviously be confusing.

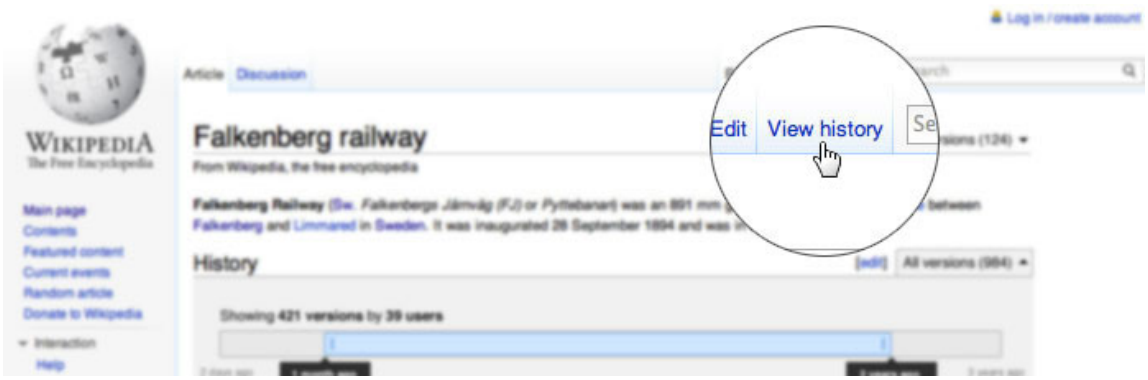



**Figure 4.33** - The view history-link in the Wikipedia interface

## Analyzing the user tests

The data from the first user tests were analyzed by making rough transcripts from the tests, followed by a KJ-method session in order to identify the most common thoughts, ideas, problems and benefits of the prototypes (figure 4.34). This analysis of the test results made it quite clear that the prototype that was the easiest to understand was the Paper Pile prototype, mostly because the metaphor (each version written on a new sheet of paper) felt natural to the users. Therefore, the main features of this prototype were considered suitable to keep in later designs, in order to be combined with useful features from the other prototypes.

**Figure 4.34** - Photo collage from the KJ-method session that was conducted after the user tests.

Some features in the prototypes were commonly mentioned, both in positive and negative wording. The single most mentioned feature in all prototypes were the use of colors to differentiate different contributors from each other. All of the users had problems interpreting the meaning of the colors, and this must therefore be made a lot clearer and easier to understand in the final prototype. The colors also needs to be well chosen in order to blend in with the rest of the Wikipedia interface. Many users liked the overview that the bar provided in the Zoomed Timeline prototype, most of them did, however, not understand the bar without having it described to them first. Some users also found the bar somewhat to visually dominant, and even intrusive, and many liked the subtle first states used in the Time Filter and the Paper Pile prototypes better. Therefore, the bar was not included in later designs. The Time Filter prototype was the one that seemed best at clarifying that the historical versions being displayed belonged to a certain *section* of an article, and that they were not versions of the entire article. The gray background and the fact that the historical versions were displayed right underneath the headline of the section were probably the main reasons that this prototype seemed best in this sense. These features were therefore used in later designs.

A more detailed description of how the input from the first user test was dealt with will be explained in the next section, where the process of going from three prototypes toward a final design is described.

# 4.4. Towards a final design

When the results from the first user tests had been analyzed, it was clear that none of the three prototypes had a complete and easy-to-understand solution to the problem of making history visible and accessible in a Wikipedia article. Instead, there were a lot of useful features and ideas in each prototype that needed to be taken into account - and, to be honest, there were several features that needed to be improved, or even omitted, as well. Therefore, a lot of time was spent trying to make use of the best features of each prototype, and to solve all problems that were identified during the user tests, such as some elements being more difficult to understand than others.

## 4.4.1. Choosing the paper pile metaphor

During the first user tests, it became obvious that the design built around a paper pile metaphor was the one that most users thought was the easiest to comprehend. The idea of stacking every new version of a section on top of the previous ones, like adding papers to a pile, seemed to be self explanatory. This design idea therefore became the foundation when moving towards the final concept (figure 4.36). To avoid making it look like a bar diagram, and to extend the feeling of a pile of paper, a small visual effect was added. By letting every representation of a version cast a small shadow on the version to the right, the feeling of papers lying on top of each other was increased.

As the section history was placed in between the headline and the content, a challenge rose to connect the section history with the section headline, but also with the section content. In the early sketches, the section history was simply placed on the white background of the articles (figure 4.35). However, this way it was not obvious what section the history belonged to - there was no clear connection between the section headline and the history of that section. Several attempts were therefore made in trying to make that connection more clear. In the end, what was most effective was to use a light gray background to frame the area, from the border below the

section headline all the way down to the scroll-bar (figure 4.36). This way, everything regarding the section history was united and connected to the section headline, yet without stealing to much focus or diverging from the overall Wikipedia style. Furthermore, the typeface was chosen to be the same as the typeface used elsewhere on Wikipedia, and the text color was gray, making it blend well into the rest of the interface without being as distinct as the live article content.

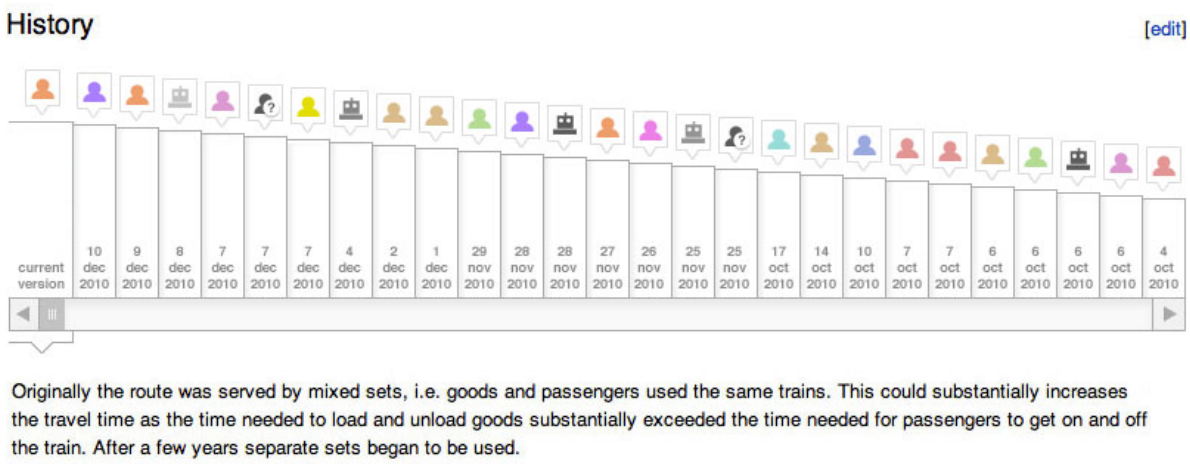



**Figure 4.35** - Early sketch, papers representing past versions are placed right on the white background.

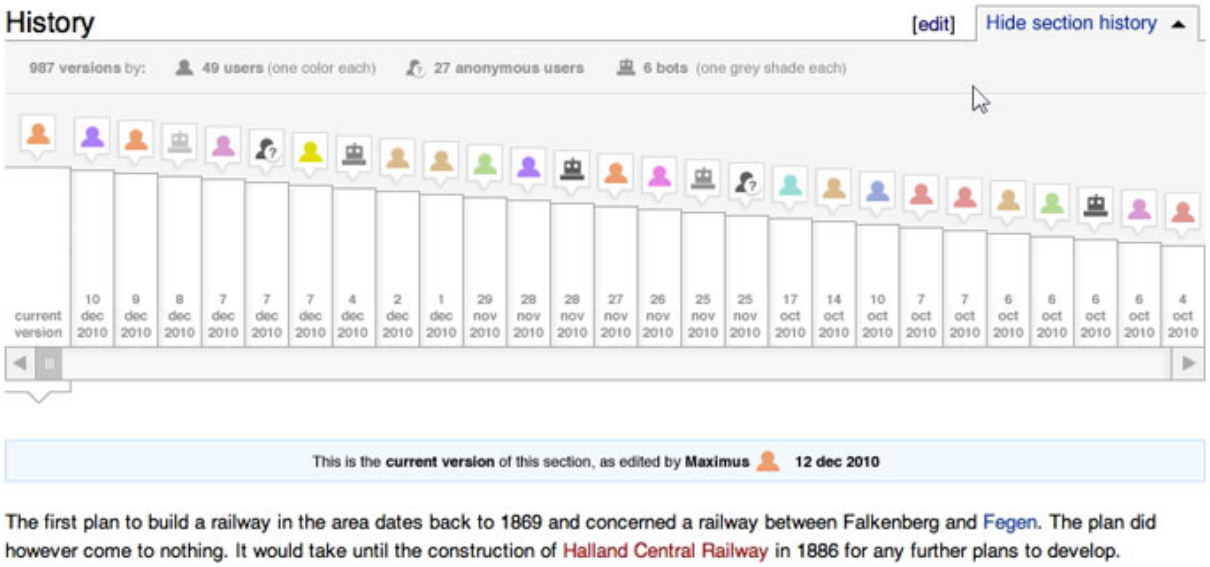



**Figure 4.36** - Concept based on the Paper Pile prototype, combining features found useful in all three previous prototypes, with a gray background to connect the section history to the section headline.

### 4.4.2. Evaluating the new prototype

After deciding to go with the paper pile prototype and following some re-design, making use of the input from the first user tests, a prototype that combined features from all three previous prototypes had been developed (figure 4.35). Therefore, a second round of user tests was conducted in order to make sure that the design now was moving in the right direction.

The second round of user tests were conducted in order to get some user input about the new prototype, and to be able to determine if it in fact was an improvement of the three previous prototypes. This round of user tests were not as thorough as the first round of tests, and they did not last as long - they were simply seen as a way of communicating with the users in order to get some input to evaluate and improve the design. Four participants were chosen (table 4.2), two from the previous user test in order to see if they found the concept better this second time, and two new participants chosen to test how understandable the concept would be for a first time user. The tests were less exhaustive, but structured in a similar way as those in the first user tests, where prototypes of the concept was shown to the participants, as they were asked to share their thoughts about what they where seeing and what they thought was happening on the screen.

| | **Gender** | **Computer experience** |
|---|---|---|
| **User1** | Female | Medium |
| **User3** | Male | Medium |
| **User7** | Female | Expert |
| **User8** | Female | Expert |

**Table 4.2** - Participants in user test 2

During this second round of user tests, it was found that the overall concept was a lot easier to understand than was any of the three previous prototypes separately. All participants were positive about the prototype and the overall design concept, but a few features still remained unclear. One such feature was the coloring of contributor icons, which still seamed to cause some confusion - especially for the two participants who did not participate in the first user test.

The other two participants (who had seen the previous prototypes) did, however, also mention that the coloring of contributor icons was still not as clear as preferred. The use of colors in the design, as well as other features that came up during the first and second rounds of user tests, will be described further in the next section, as one feature of the design is dealt with at a time.

# 5. RESULT

The result is divided into two parts, where the first part presents many of the design considerations that were made throughout the design process and that had an important impact on the outcome of the final design. The second part of the result presents the design that was finally reached, after several iterations of design, evaluation, discussion and re-design. It also describes how the final design dealt with the different objectives stated at the beginning of the project.

## 5.1. Design rationale and considerations

Throughout the design process numerous design decisions had to be made in order to reach the final design. The importance of the decisions and their impact on the final design varied from minor to major, and the most important considerations will be presented here, as they might be of interest to other designers.

### 5.1.1. Changes in height, saving some screen space

The height of the papers representing old versions were decreasing in the design, in order to create an effect of older papers being further away. However, after showing the prototype to Karin Ackerholm, an experienced interaction designer, it became clear that this could be considered pixel greedy. Further, it leaves an unused spot in the upper right corner, as the papers decreases in height from left to right. Therefore, the effect of decreasing the height of the papers was removed (figure 5.1), which allowed for the entire height of the pile to be decreased, as the height no longer needed to allow for a fall of by time. As a positive side effect, this makes the design less complicated to implement.

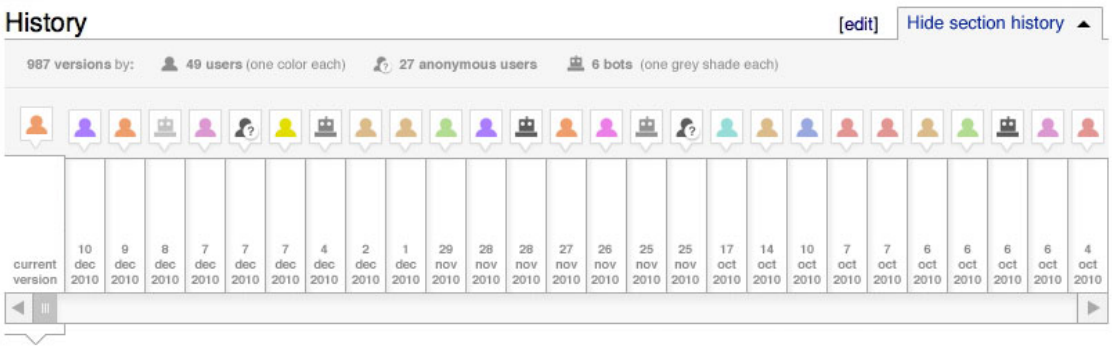



**Figure 5.1** - Height of the papers no longer decreasing. Thus using the screen space more efficiently.

In the early sketches, the paper flaps were made distinctively higher than they were wide, to clearly indicate that they are versions (papers on top of each other) and not blocks or bars on a row. However, unnecessary height consumes a lot of space on the screen and inspiration on how to create a similar effect, without the use of height, was therefore sought for in other designs. As pointed out by the thesis supervisor, inspiration could be found in iTunes Cover Flow[20], and by introducing a diagonal top-border on each paper flap, the desired effect could be achieved without using unnecessary height (figure 5.2). Together with the drop-shadow effect, the flaps could be designed using considerably less height, yet still looking like papers in a pile.

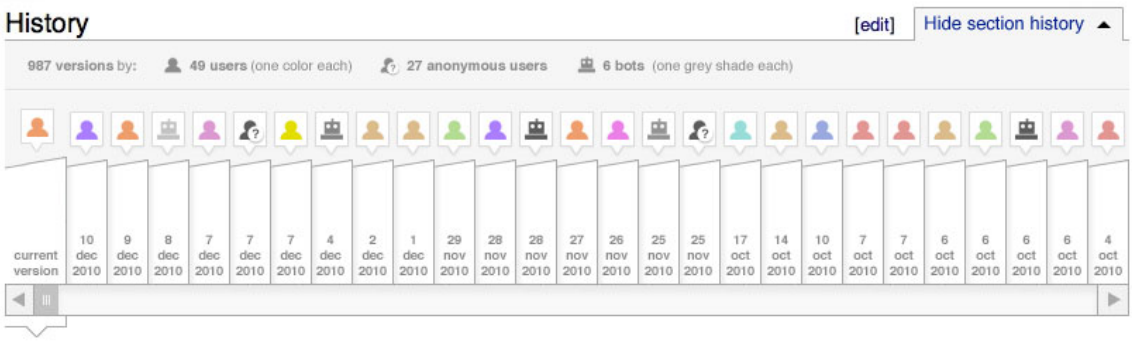



**Figure 5.2** - the top of each paper (old version) being diagonal, to make it look more like papers stacked on top of each other in a pile.

[20] iTunes is a mediaplayer from Apple, Cover Flow is a mode where album covers are displayed in the interface.

When a section of an article has more versions than what is possible to show in one screen, older versions will be accessible using a horizontal scroll-bar. It was first considered to use some kind of visual clue to indicate that more old versions could be accessed if scrolling. For this, many techniques were tried, such as using shadows on the rightmost versions, fading, dots, and papers that were "cut off". Unfortunately, none of the ideas provided a satisfying result, and the idea was therefore discarded. However, the scroll-bar can probably be considered a sufficient clue about there being more content to display, and when looking at web browsers and other applications, a scroll-bar is often the only indicator that more content exist outside the current screen.

### 5.1.2. Choosing the compact state of the Time Filter prototype

A common feature in all of the three prototypes, shown in the first user tests, was that some information was given to the users prior to actively choosing to display more historical content. In the Paper Pile prototype, a representation of the ten latest versions was displayed when hovering the mouse over tabs in the top right corner of a section (figure 5.3). In the Zoomed Timeline prototype, a representation of all previous version of a section was displayed in gray-scale below each section, and when hovering the cursor over them, all are displayed in different colors depending on who contributed to the section (figure 5.4). And finally, in the Time Filter prototype, the number of total versions of a section was displayed in a tab above the section content (figure 5.5). In all three prototypes, this information was designed to be a permanent part of the interface in order to provide users with a first cue about the amounts of edits done in a particular section and/or to give an idea of how many users had contributed to the section. Many of the participants liked the design of the compact state that the Paper Pile prototype provided, as well as the overview in the compact state of the Zoomed Timeline. However, the results from the first user tests strongly indicated that users had problems understanding the information presented to them in both of these compact states. Moreover, in cases where a large amount of versions of a section (500 or more) have been created, it would be very difficult to identify the information displayed in the Zoomed Timeline prototype. There would simply be too many small representations of versions and too many different colors representing contributors to make it possible to separate them and get an idea of how many versions or contributors there where. For

these reasons, the compact state of the Time Filter prototype were found the most suitable, since it did not confuse the users and was not found intrusive in the interface.

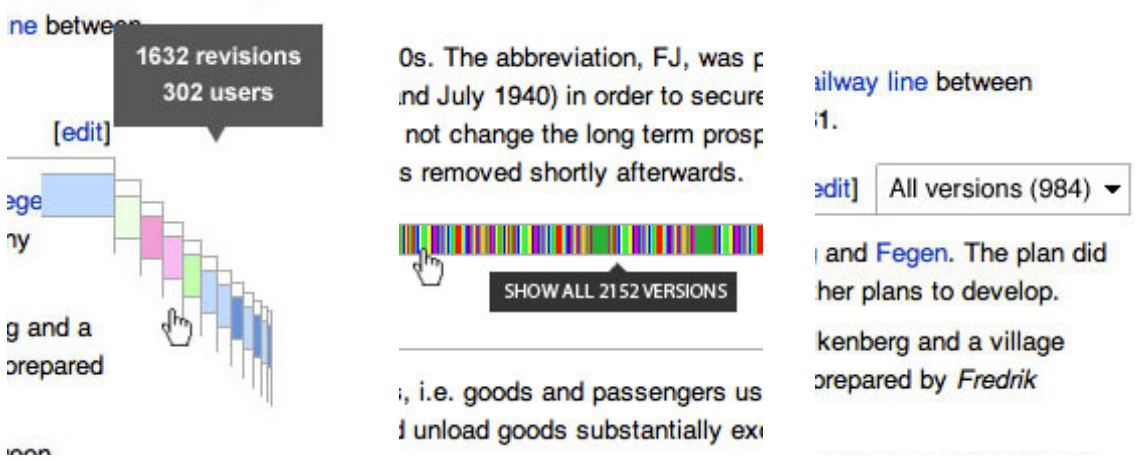



**Figure 5.3** - Paper Pile prototype
**Figure 5.4** - Zoomed Timeline prototype
**Figure 5.5** - Time Filter prototype

Since there was some confusion, during the first user tests, about the difference between the 'View history'-link in the Wikipedia interface and the 'All versions'-link in this design - the text was changed from 'All versions' to 'View section history'. Thereby indicating that the historical content accessible via the link would be that of the section and nothing else. When clicked, the link would change to 'Hide section history'.

### 5.1.3. Navigating through history

When a section of an article has more versions than what is possible to show in one screen, navigation will be possible through a horizontal scroll-bar. When dragging the scroller back and forth, the paper tabs will slide with it, revealing versions previously not visible on the screen. In the early sketches, two different kinds of scroll-bars were evaluated, one being a regular scroll-bar and the other being more of a zoomed out time-axis where the user chose what part of the axis to focus on (figure 5.6).


**Figure 5.6** - Two different types of scroll-bars evaluated during the first user test. The regular scroll-bar at the top and the time-axis below.

During the first user test the two different scroll-bars where discussed with each participant. All participants agreed that the regular scroll-bar was easy to understand, and that it was obvious what would happen if they dragged the scroller. The participants that were considered expert computer users also liked the more advanced scroll-bar, where the time-axis provided an overview of all previous versions of the section. However, those with medium computer experience had a hard time understanding the concept and felt that it was unclear how to interact with the scroller. The negative effects of the more advanced scroller were predominant to the positive, and the regular scroll-bar was therefore chosen.

When it had been decided to go with the regular scroll-bar, a couple of mockups were made using the default scroll-bar style provided by the computers operating system. This scroll-bar however was considered too eye-catching, especially in Mac OSX where it has a highlighted blue color and a glossy effect (figure 5.7). A custom scroll-bar style was therefore designed, to make the scroll-bar fit in with the rest of the elements. The first drafts of the new scroll-bar were flat, without any 3D-effects at all (figure 5.6), and therefore did not afford any interaction, as Donald Norman (Norman, 1988) would have said. By adding a slight gradient to the scroller it becomes more affordable, still without stealing too much focus from the more important content (figure 5.8).

**Figure 5.7** - The default scroll-bar style provided by Mac OS X.

**Figure 5.8** - Customized scroll-bar style, to make the scroll-bar more compatible with the Wikipedia design.

## 5.1.4. Displaying temporal information

It was found, during the first round of tests, that many of the users had problems understanding the temporal information in all three of the prototypes. Many of the users did, however, like the idea of displaying information about when a version was created on the representation of that version. This was done in the Paper Pile prototype, but in that prototype the information was written in terms of how long ago the version was created, e.g. “2 days”, or “4 months”. The problem with this was that it confused some of the users into thinking it might be the age difference between two versions following each other in time, which it was not. Another problem was that it would make it difficult to look for versions created during a given interval in time, since one would have to count backwards in order to determine what particular dates “4 months” was a reference to. Therefore, in order to simplify things, the creation dates of the versions were included in the interface. This time, however, it was not displayed vertically as done in the Paper Pile prototype, but horizontally in order to make it easier to read (figure 5.9).


**Figure 5.9** - Timestamp displayed horizontally in order make it easy to read.

Already in the beginning of the design process, there was a clear intention of making visible as much of a sections’ history as possible in the interface, in order to provide as much of an overview as could be achieved in a useful way. The work of making as much use of the screen real-estate as possible therefore continued throughout the design process, which also affected the temporal information being displayed. The choice to display the information horizontally to ease reading, resulted in each representation of a version had to become somewhat wider in order to fit all information. By placing date, month and year on separate rows, the required width could be shrunken somewhat. This also resulted a positive side effect, making it easier to quickly scroll

through many versions to get to a certain year, since this information did not move around as a result of various lengths in month name or date. Thereby it became easier to simply focus on the characters representing the year in the interface while scrolling. To further decrease the width of each versions paper tab in the interface, various ideas were tested through design sketching. One idea was to display the year, which was the most space consuming date element, as "´11" instead of "2011" to save some space. After discussing it, it was agreed the most suitable way of displaying the year was in full length, since it was the easiest to read. Also, the shortened version ('11) would only save as much width as making room for a handful of extra versions at best, therefore, clarity was chosen over a somewhat increased overview. When tested, none of the users in the second user tests had any problems understanding the temporal information and how it was displayed. Both of the expert users did, however, mention that they liked the fact that they could scroll through many versions in the interface while seeing when they were created.

The small typeface used in the Paper Pile prototype was kept, since it was as small as could be while still maintaining high readability. However, a darker shade of gray was chosen in order to make the text somewhat clearer. A black, or very dark gray shade of the type was tried as well, but that that made the temporal information become visually dominant in the interface which was not intended - it should be seen as meta information about the main content in the design, which is the contributor icons and the version tabs themselves (and obviously the article content).

### 5.1.5. Distinguishing between different contributors

Colors were used early on in order to distinguish different contributors from each other. In all three prototypes tested in the first user tests, each contributor was represented by a unique color. This was found confusing for the users, and the idea should perhaps have been abandoned at this point, but there were no better idea of how to visualize how many contributors took part and at the same time showing how much they each contributed. Since coloring the contributor icons, as done in the Time Filter prototype, seemed the easiest to understand, this replaced the colored ribbons. In the first draft using the colored contributor icons, the icons were placed on the same spot as the ribbons previously lay (figure 5.10). In this spot however, the icon felt misplaced. By instead placing the user icon up above each paper (figure 5.11), it became more of a description, or meta-data, to the version. This way information that directly related to the version, such as

date of creation, could be presented on the paper tab, while information about the author could be presented in relation to the user icon, but somewhat disconnected from the version.

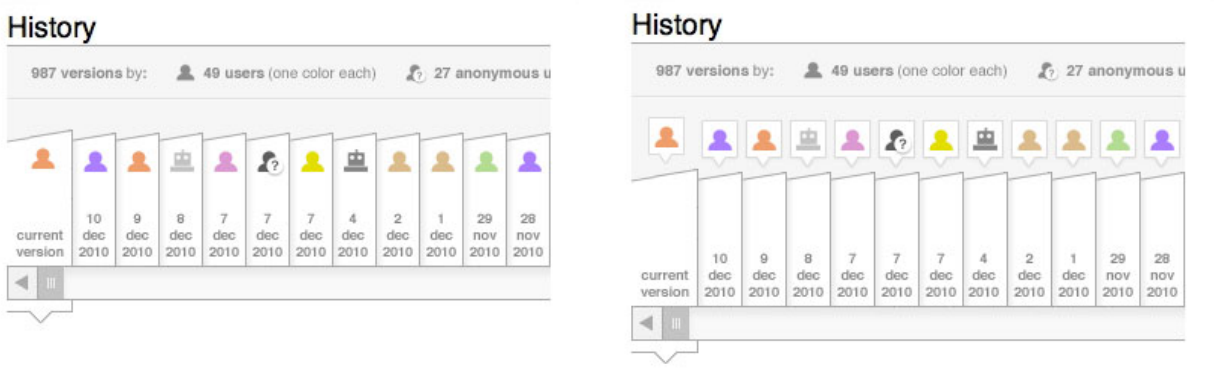



**Figure 5.10** - Contributor icons displayed on each paper
**Figure 5.11** - Contributor icons displayed above each paper

It became obvious, during both the first and second round of user tests, that ordinary Wikipedia users do not know that it is possible to edit a Wikipedia article anonymously, without having a Wikipedia account. All participants in the tests were also unaware that a large number of edits were performed by automated [ro]bot users. Therefore, it was decided that the design should make it possible for users to distinguish between versions of a section made by contributors who were registered users, anonymous users and bots. Apart from the contributor icons used in the Time Filter prototype, two more icons were created; a small robot icon to indicate bot users; and an icon similar to the one used for registered users, but with an added question mark, to indicate anonymous users (figure 5.12).

**Figure 5.12** - Contributor icons; registered users, anonymous users and bot users.

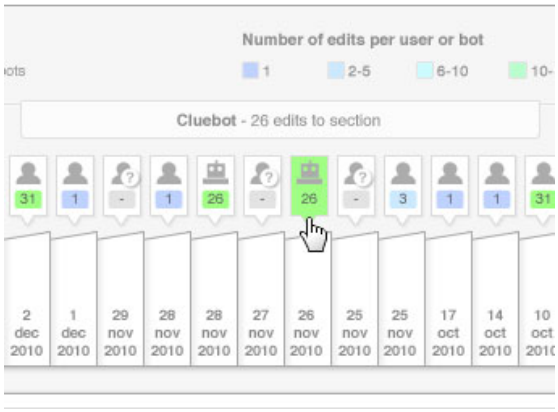
The idea of distinguishing individual contributors by coloring their icons in different colors was finally abandoned after the second round of user tests. Even after adding an explaining legend to the interface (see section 5.1.6), the meaning of the colors was confusing to the users. Also, with many contributors to a section, there would be so many different colors that the shades would simply not be distinguishable from each other, thereby failing the entire purpose of the colored contributor icons. However, the idea of using color as some kind of indicator still prevailed.

Two of the main objectives for the project was to make it visible how many contributors had been involved in creating the article, and if any contributor had contributed more than others. This still needed to be visible in the interface, but not by the users having to count the number of instances a blue, red or pink colored contributor icons appeared. Therefore, a new piece of information was introduced in the GUI; the number of edits by a contributor to a section, presented as a number. This was added below the contributor icon (figure 5.13). To make it easier to quickly scan through different users, intervals of edits were assigned colors, and the interval that number of contributions belonged to was used as a background color, behind the number. In other words, if a contributor made 6 edits, the number 6 would be displayed, and behind it would be the color of the '6-10 edits' interval. For anonymous users, a hyphen was printed instead of the number of contributions, and a gray color was used as background, since it is not possible to know how many times they have contributed.


**Figure 5.13** - Final design: Number of edits by a contributor and an icon indicating type of contributor. Color behind the number represents an interval number of edits.

Another possibility, apart from displaying the number of edits a contributor made to a *section* of an article, would have been to display the number of contributions to the *entire* article, or perhaps the number of contributions to Wikipedia all together. However, the number of contributions to the entire article seemed confusing, as all other information was related to a specific section of the article. The same reason is applicable for why not to display the total number of contributions to Wikipedia. Even though the initial thought was to only use color for contributors that were registered Wikipedia, it was decided to use colors for bot users as well, in accordance with the same coloring scheme. As different bots performs different sets of tasks on Wikipedia, the reasoning was that it could be interesting to see if some bots were editing specific sections more frequently than others. For anonymous contributors, the coloring scheme was not applicable since those users are only known via their IP-address. It is therefore not possible to determine how many edits a person has made, as multiple persons can use the same IP-address, and a single person can edit using several different IP-addresses. Therefore, a gray shade was used for all anonymous users - separating them from registered users and bots.

When color was no longer used to identify different contributors, a need for a new way to differentiate them emerged, since it still could be interesting to be able to see what a certain contributor had done. One thing that was unique for all contributors and bots was their username, and for anonymous users the corresponding information would be their IP-address. This information could therefore be added to the interface, making it possible to distinguish different contributors from each other. A way to do this would have been to show it in relation to the user icon. This would, however, have cluttered the design, and as the information was considered meta-data to the section history, it was not important enough to award as much space and focus. Therefore, usernames (and IP-addresses for anonymous users) was added, but only to be displayed when hovering a user icon with the cursor. This way, users could see such information when interesed, without the information occupying any screen space by default. The design decision that had to be made was where to display the information on mouse hover. Several different placements were evaluated, ranging from displaying the information in a box above the papers (figure 5.14), or on top of the papers (figure 5.15), to lifting up the user icon above the others and revealing the information next to the icon (figure 5.16). The final solution was to display the username as a tooltip above the user icon (figure 5.17).



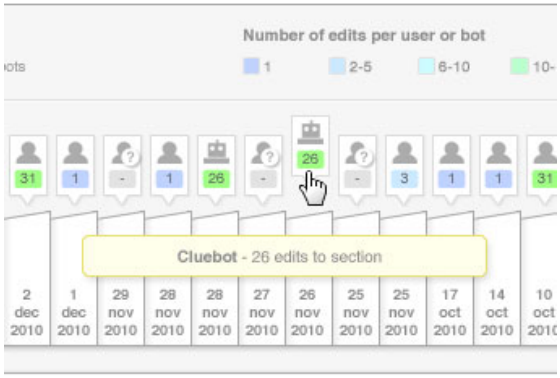
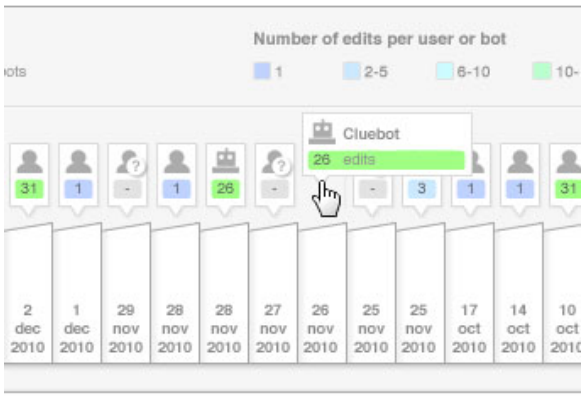




**Figure 5.14** - Username above the papers
**Figure 5.15** - Username on top of the papers



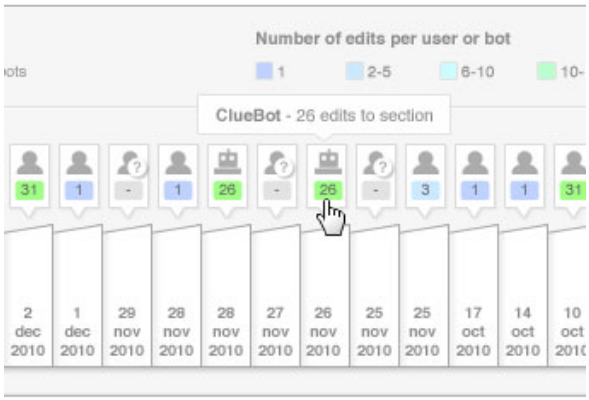




**Figure 5.16** - Username in a tooltip
**Figure 5.17** - Final choice

In order to make it possible for users to focus on the contributions of a single contributor, to see what the contributor had done in the past, the contributor icons were made clickable. By clicking on a contributor icon, versions created by that contributor was kept in the interface, and all other versions were filtered out (figure 5.3). To get back to viewing all versions of the section, the user could click on the contributor icon a second time, releasing the filter.

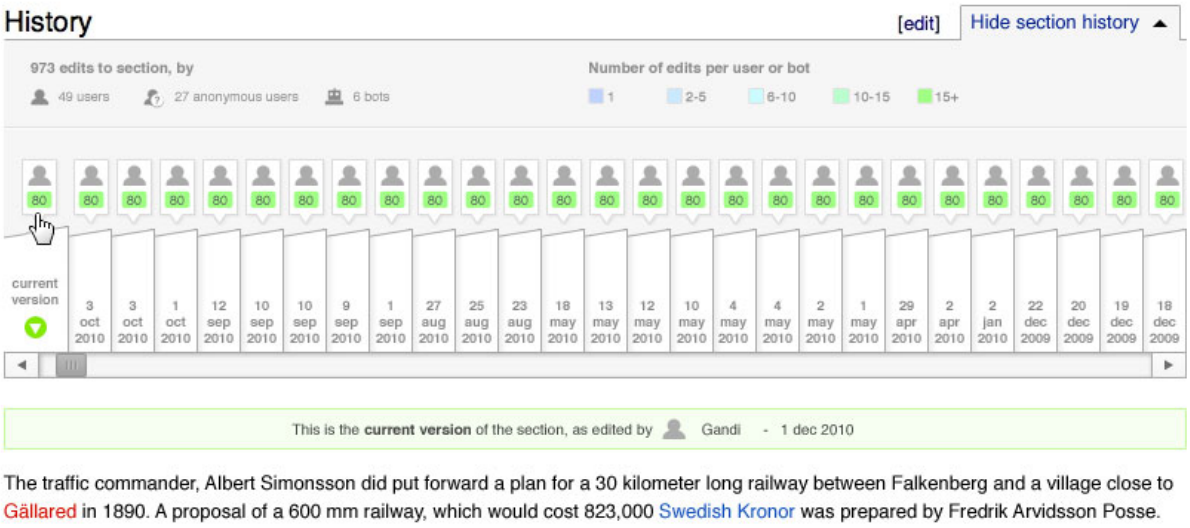



**Figure 5.3** - The user has clicked a contributor box to display versions created by that contributor only.

All colors used in the design are toned down to not interfere with the subtle style of the Wikipedia interface. Further, some colors such as red and green, which often represents a warning or a confirmation of some kind, confused many users during the tests. To not cause any confusion, red colors were avoided in the interface, thereby removing the risk of interpreting red and green as two extremes in a color scale.

### 5.1.6. Need for an explanatory legend

During both the first and second user tests the participants had a hard time interpreting the color indications. To make it easier to understand the colors as well as the user icons, an explanatory legend was introduced in the design. In several sketches different layouts and different kinds of information were evaluated (figure 5.18), to see what kind of legend provided most support to the user.


**Figure 5.18** - Various layouts evaluated for the explanatory legend.

In the end, what made most sense was to use the legend to clarify the color indication and to introduce the different user icons. Along with the user icons, some statistical information was presented, stating the total number of versions of the section and the number of contributions per user type. This way the legend became more than just explanatory, it also provided additional information not previously available in the design. When it came to making the color indication more clear, the first drafts for the legend used a color scale. The color scale however was to eye catching and stole focus from more important parts of the design. The color scale was therefore replaced with small colored boxes (figure 5.19) that were more discrete but equally explanatory.


**Figure 5.19** - Final design: This was the final legend layout with more discrete color usage.

To make the design easier to understand and to use, some elements were added to the legend to guide the users. One such element was the tooltip that was displayed when a user hovered the mouse cursor over a contributor icon in the legend (figure 5.20:A), which was intended to clarify the meaning of the icons, if the user was confused. A similar tooltip was displayed when the user was hovering the cursor over the colored boxes in the legend (figure 5.20:B). This tooltip was

intended to clarify what each color represented, by giving the users a short description of the meaning of each color.

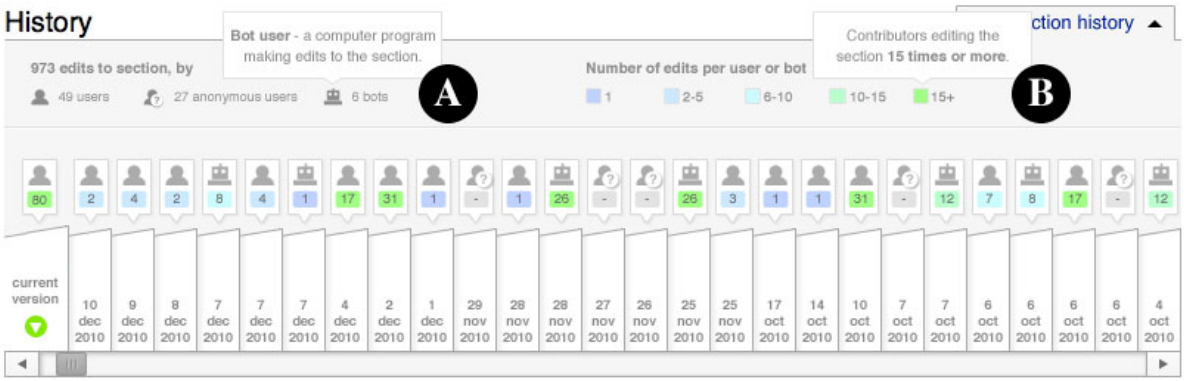



**Figure 5.20** - Final design:
A - Tooltip explaining the contributor icons, displayed when an icon in the legend was hovered.
B - Tooltip explaining the colored boxes in the legend, displayed when a colored box was hovered.

## 5.1.7. Highlighting the currently displayed version

A feature that many of the participants in the first user test liked was the ability to see the section content as they were browsing a sections history. Therefore, this feature was kept in the following designs, resulting in a challenge of clearly distinguishing the paper tab of the version whose content was currently being displayed, from the other tabs. In prototype used during the first user test the tab of the version being displayed had an arrow pointing up, towards the text of that version (figure 5.21). This was found easy to understand during the first user test, and an equally understandable feature was therefore to be included in the new design. The problem was that, in the first prototype, the section history had been placed below the section content, therefore making it easy to add an upwards pointing arrow to the tabs. In the new design, the section history was placed above the section content, thus requiring a downward pointing arrow instead. However, between the tabs and the section content in the new design, a scroll-bar was located. An arrow at bottom the paper tab could therefore easily be misinterpreted as pointing to a certain point on the scroll-bar. To avoid such confusion, the tab of the version being displayed was extended below the scroll-bar and given an arrow in the bottom (figure 5.22). This did,

however, turn out to be troublesome since a few people who saw the designs still were confused about whether arrow was connected to the scroll-bar or to the paper tab.

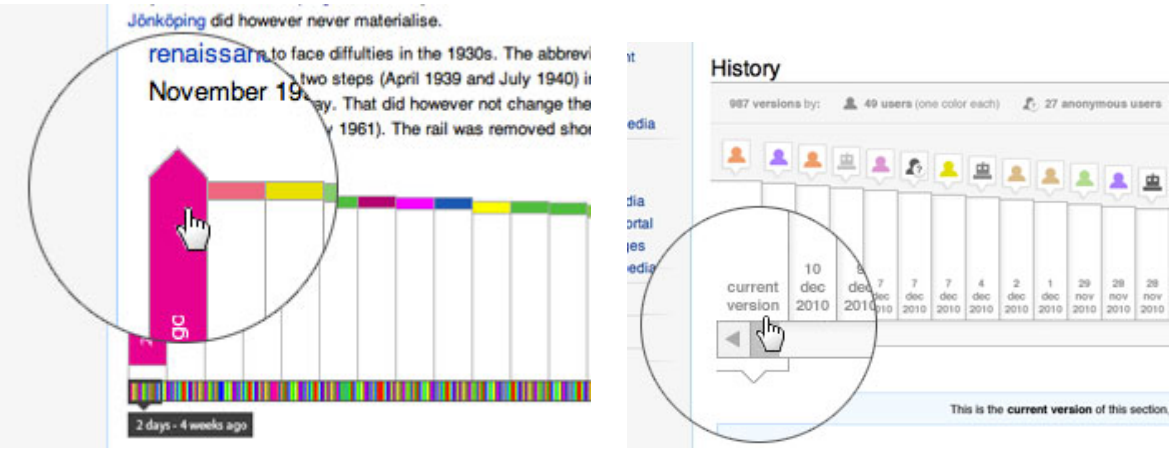



**Figure 5.21** - Early prototype where an arrow was used to display what version the displayed content belonged to.

**Figure 5.22** - The arrow approach was applied to the Paper Pile prototype in an attempt to display what version was currently being displayed.

Instead of turning the bottom part of a tab into an arrow in order to show what version was being displayed, various other ideas were evaluated. Other types of arrows as well as numerous symbols were considered possible indicators. However, no design in which the indicator was placed below the scroll-bar was intuitive enough, and would furthermore be complicated to implement on a web page. Placing the indicator above the paper tabs was a possible option, but this would not make as much sense since it would not be connected visually to the content being displayed. For these reasons all ideas with an indicator *below* the scroll-bar or *above* the tabs were rejected.

To distinguish the displayed version from the rest without using indicators above the paper tabs or below the scroll-bar, only one option remained - using the space *inside* the tab elements. Various ideas trying this out was designed, where a few of them were based on the idea of coloring the paper tab of the displayed version, as seen in figure 5.23. This added more color to

the interface, which after discussions was found not completely suitable since it made the design blend in less with the Wikipedia interface. The tabs could, however, be colored in a discrete color, or in a shade of gray, but this almost made the tab less visible than the others which were white, and therefore the coloring was in some sense contra productive. Finally, it was decided that the best way to distinguish the version being displayed was to use some kind of arrow-icon inside the tabs. This was chosen to be discrete, but clearly visible, and most likely easy to understand, since similar concepts are used in various applications. In order to place the arrow-icon as close as possible to the content it was pointing at, the icon was placed at the bottom of the tab, placing the timestamp above it (figure 5.24:A). To make it more obvious to the users that the paper tabs could be clicked, to display the content of that version, a hover-effect was added that displayed a pale version of the arrow-icon at the bottom of the tab when hovering it with the cursor (figure 5.24:B). When clicked, the icon would get a darker gray shade, indicating that the version now is being displayed.

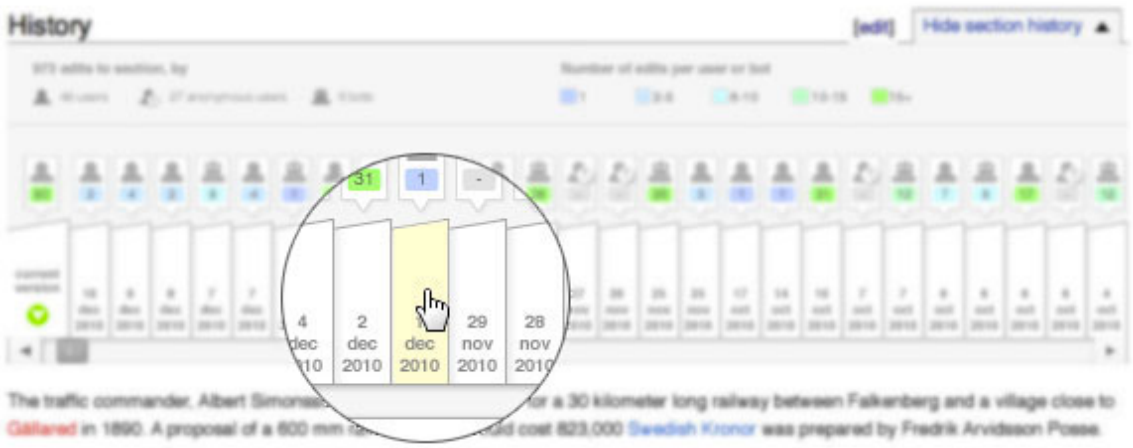



**Figure 5.23** - A colored tab indicated what version was being displayed.

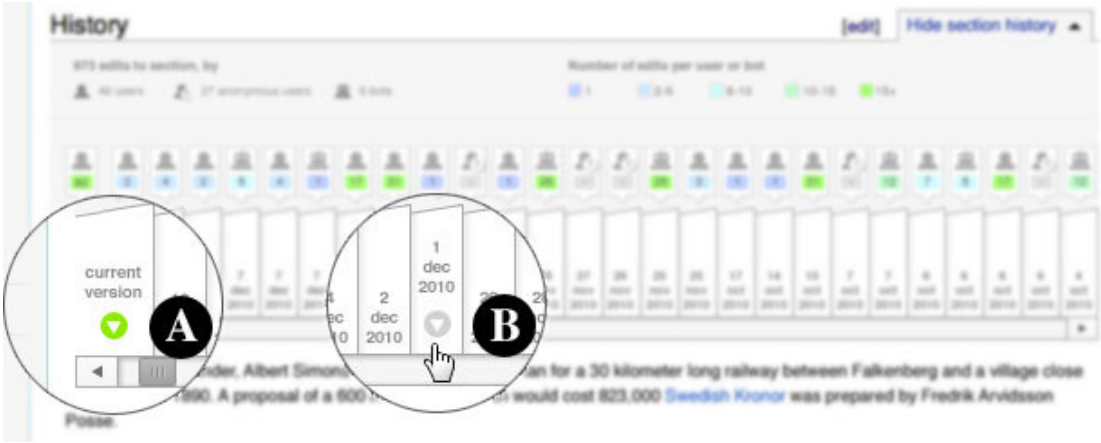



**Figure 5.24** - Final design:
A – A green arrow-icon indicating that the version is currently being displayed.
B - A pale arrow-icon displayed when the tab is hovered, to provide a clue that the tab can be clicked to display the content of that version.

## 5.1.8. Distinguishing between current and old content

It was found during the first user tests that the users did not only want a clear indication of what version was being displayed, they also wanted to be able to quickly identify the current version among the others. Many of the users mentioned that the broader paper tab used to represent the current version of a section (figure 5.24:A) - which was used already in the early versions of the paper pile prototype - was a good way to identify what version was the most recently created. The broader paper tab of the current version was therefore kept throughout the design process. In order to separate the current versions' tab even more from older ones, this tab was given a green arrow-icon when the version content was being displayed instead of a gray arrow-icon which is used on old versions. The green color was chosen since green often indicates something being *"ok"* or *"good"*, and since the current version is the only version that still have not been revised, it could be considered more relevant than older versions.

It was also found that, when displaying the content of an old version, it should be obvious to the users that the content being displayed is in fact old, and should therefore not be mistaken for that of the current version. In order to make visible what content was being displayed, a rectangular box was introduced just above the content of each section. The box contained a text stating that the content below was that of the current version (figure 5.25), or that of an old version (figure 5.26).

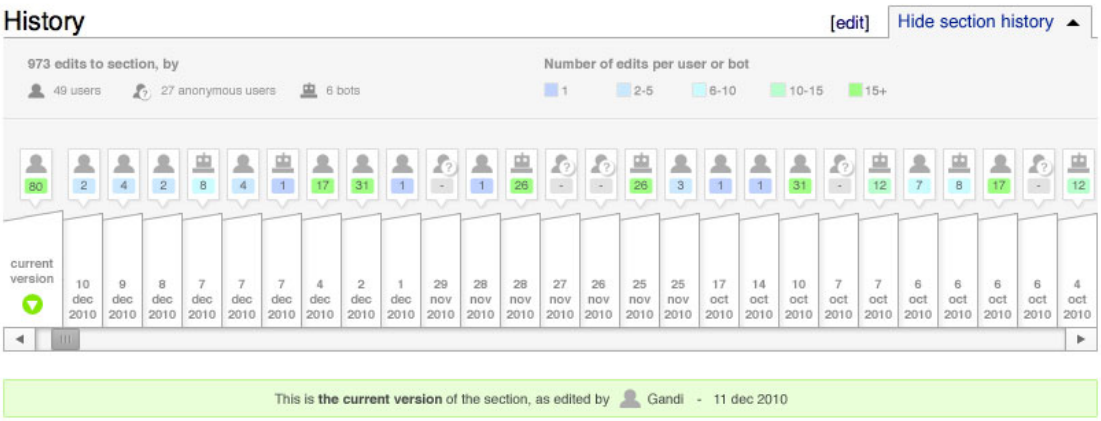



**Figure 5.25** - Final design: the green notice box informs the users that it is the content of the most recent version that is currently being displayed.

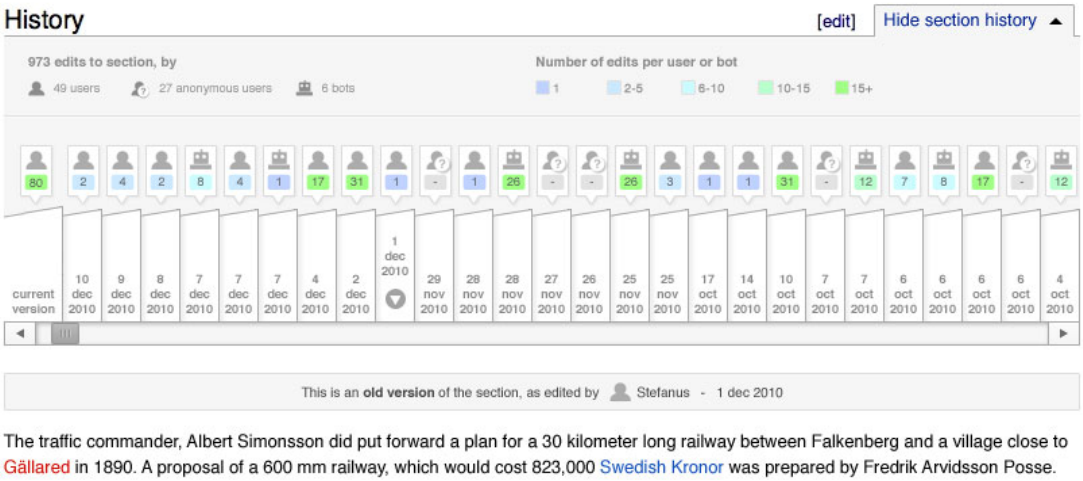



**Figure 5.26** - The gray notice box informs the users that it is content from an old version that is currently being displayed.

Using a notice box when old content was being displayed was not enough though, since sections of an article often can become longer than what would fit on a single screen. Sometimes, the notice box would not be visible on the screen because the user had scrolled down. In those cases some extra indication was needed, stating that the content was that of an old version. To deal with this, coloring of the text was first evaluated, making the text of an old version turn gray in order to distinguish it from the text of the current version (figure 5.27). This was, however, not a

good solution since it made the text more difficult to read. Moreover, it did not provide a solution for sections where no text was used, such as in sections with only images or data tables. Therefore another idea was needed, and for this, inspiration was found in forums, e-mail applications and comment sections which all used one trick to display old content: text indent. Adding intent to content that was old would make it recognizable even when the notice box might not be visible. However, the width of the indent should be limited to a minimum, since the more width used the less space would be left for the content. On the other hand, the indent should be given as much width as needed in order to make it clearly visible and recognizable at all times. To deal with this, a gray vertical line was placed to left of the indent, making it more visible without using too much width (figure 5.28). This is also a feature used elsewhere, such as in e-mail applications where it is used to indicate what text belongs to previous emails (figure 5.29).

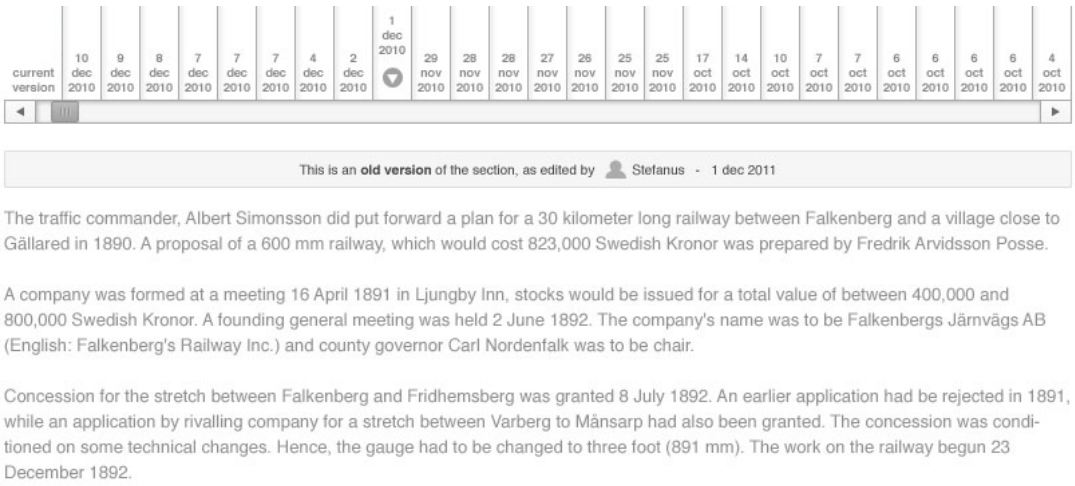



**Figure 5.27** - When displaying content of previous versions, the text was first given a gray color to indicate that it was old.

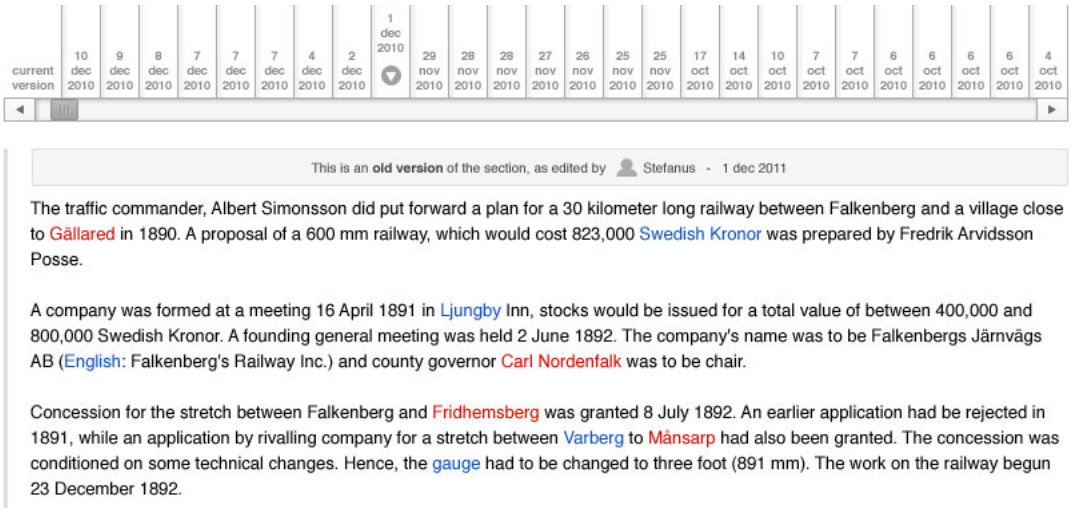



**Figure 5.28** - Final design: Text indentation and a gray vertical line was used to indicate the content did not belong to the most recent version of the section.

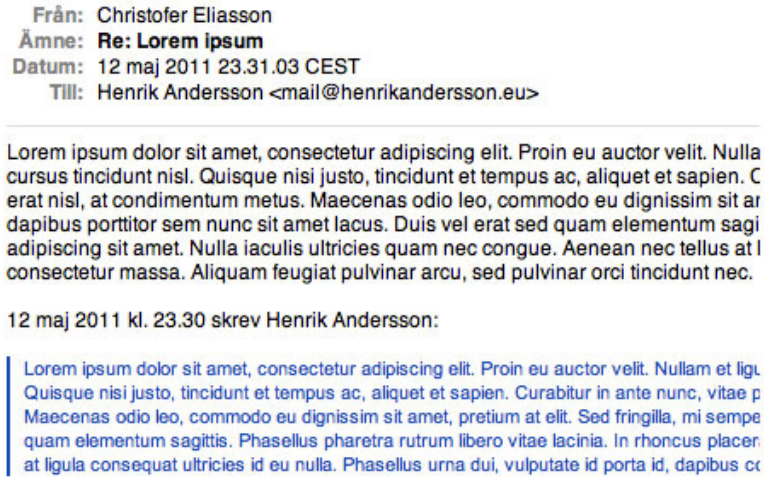



**Figure 5.29** - Example from Apple Mail of how text indent is used to indicate old content. Blue text is from an old e-mail, and black text is new.

## 5.2. Final design

When all features of the design had been examined and discussed, re-designed, tested and re-designed again through iterations, a final design was reached (figure 5.30-5.32). The design now dealt with the various problems and possibilities discovered throughout the design process, and incorporated the solutions into a single design concept.

A few objectives for the project, that were stated early on, served as a guide during the entire design process. These objectives stated that the design should make it possible for the user to determine whether a section of an article had been edited many times or just a few. Using the paper pile metaphor it was relatively easy for the users to get an idea of whether there were few or many versions of a section, just by looking at the pile of papers. It was also stated that a user should be able to see whether many or few contributors had been involved in creating the section. To make this information as accessible as possible, the explanatory legend was extended with information about the number of contributors of each user type. Further, the objectives stated that it should be possible to see if some contributors had been more involved than others. This objective was met by adding each contributor's number of contributions as meta-data below the contributor icon. The user could then easily see if some contributors had performed more edits than others.

In addition to the objectives stated in the beginning of the project, some important aspects to consider were identified throughout the design process. One of these aspects was that the users should not only be able to identify if some contributors were more involved than others, they should also be able to identify who the contributor was, and whether it was a registered user, an anonymous user or a [ro]bot doing the editing. To meet this objective, the contributor icons were introduced. Attached to each versions paper tab, the contributor icons indicated what type of contributor had created that version. It was also made possible for the users to hover the contributor icon to reveal information about the username or the IP-address of the contributor. Moreover, it was decided that the users should be able to see if a section had been edited many times in the recent past, and if there had been periods of more extensive editing. By adding the date of creation to each version in the design, the users could use the horizontal scroll-bar to browse through the history and get an idea of when editing took place. Another feature that

should be made possible, was to browse the history of a section not only through time, but also based on contributor - that is, a user should be able to filter out versions of a section made by a certain contributor. This was done by making the contributor icons clickable, thus filtering out the versions of the contributor in question. It was also desirable that the design should blend in well with the Wikipedia interface, and a lot of focus was placed on the colors in the design, trying to use the same light color palette that was used in the rest of the Wikipedia GUI. A customized scroll-bar layout was also designed, to make sure that the horizontal scroll-bar did not steal to much focus in the otherwise subtle design. Another requirement that came up, was that the visualized historical content should use no more screen space than necessary. To incorporate this, the section history was added so that the users could choose to show and hide the history whenever they wanted. Moreover, and perhaps most importantly, the objectives stated that the design should be made easy to understand and that it should be practical to use. The explanatory legend was also introduced, explaining the colors and the contributor icons used in the design. Further, tool tips were added to several of the elements in the design, so that the user could hover them with the mouse cursor and receive a short explanation of the purpose of that element.

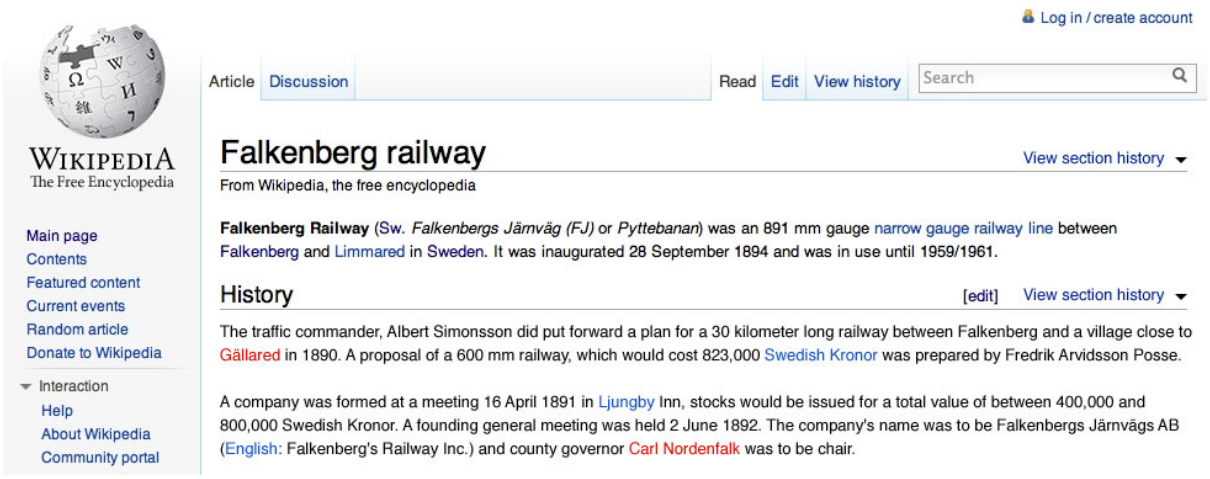



**Figure 5.30** - Final design: first state, before choosing to display the history of a section.

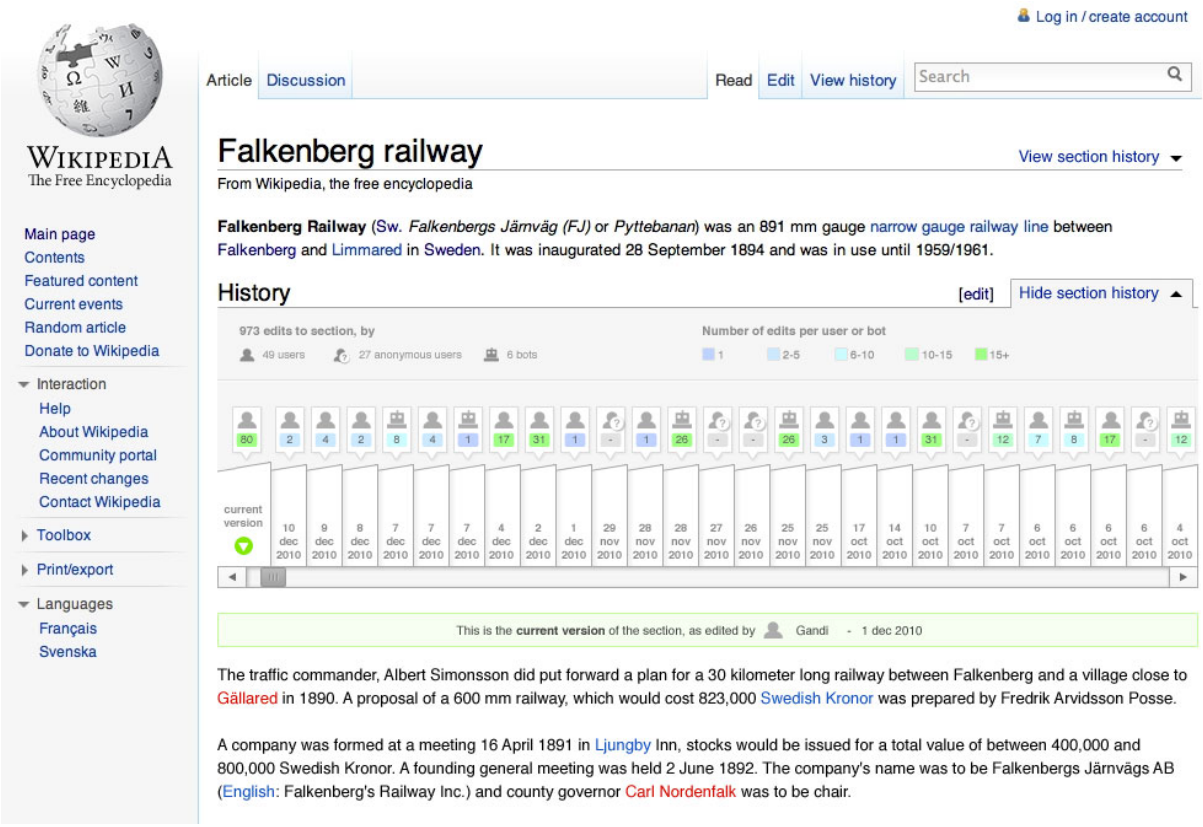



**Figure 5.31** - Final design: displaying the historical versions of a section. Current (live) content being displayed below the visualization.

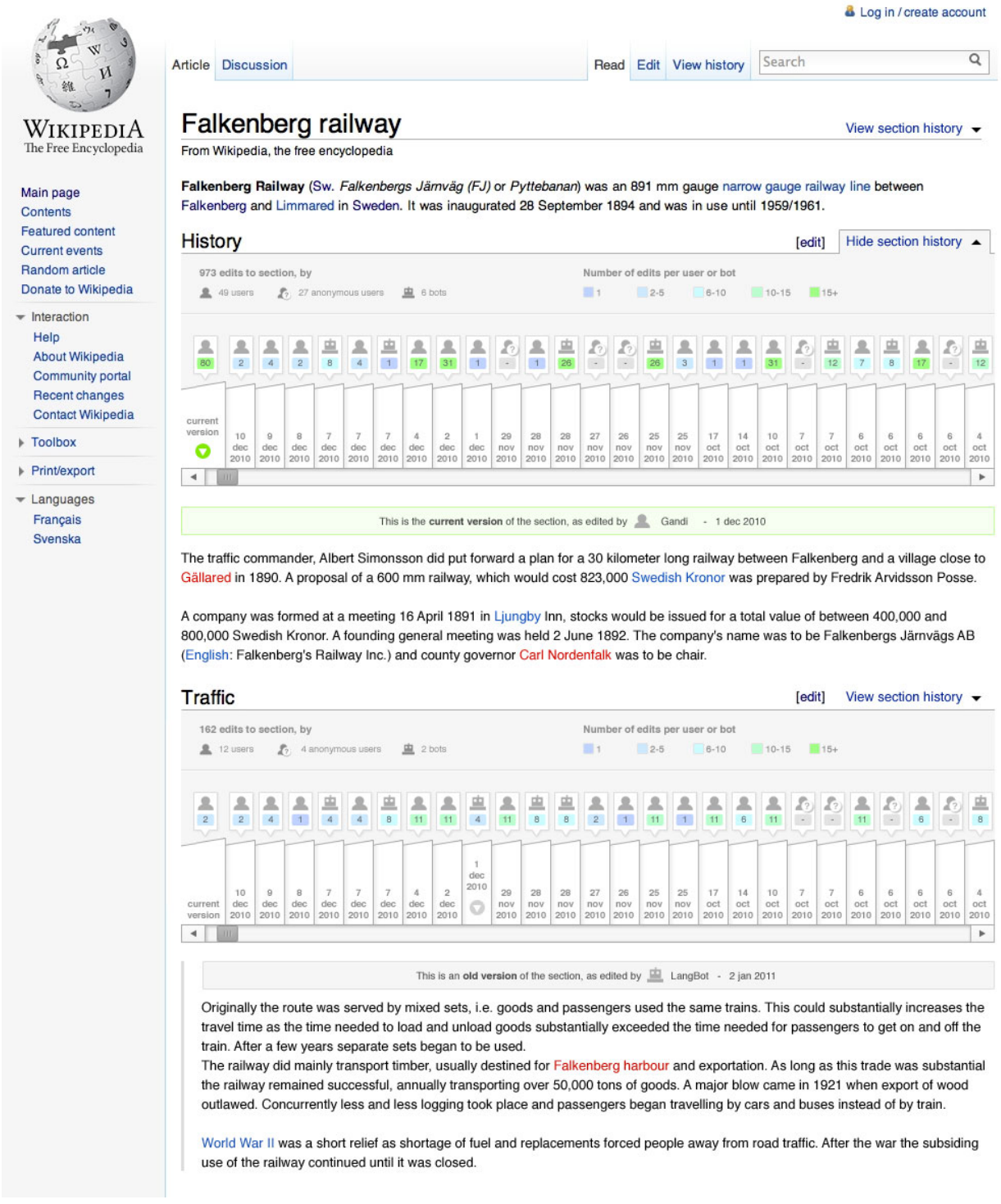



**Figure 5.32** - Final design: displaying the historical versions of two sections in an article at the same time. For the bottom section, an old version is displayed, which is indicated by the text indent and the gray information box above the section content.

# 6. IMPLEMENTING THE DESIGN

During the last couple of years, applications, or apps, have become ubiquitous. With the introduction of Apple iPhone and similar smartphones, apps were introduced to mobile phone users as a way to customize their unit, to make it more suitable to their needs. A similar development has been seen on the web, where social communities like Facebook[21] and services like Google Apps[22] open up their platforms and allow developers to create additional functionality, that is made available to the mass of users. At the time of this study, apps in that sense were not available for the Wikipedia community, however there were other ways to tweak and customize its functionality and looks.

A term that has become popular to use is hackability[23], or generability, and refers to the ability for an application or a device, to be modified in ways that were not intended by its creators. With hackability users can add new functionality, mash information from different sources and invent new ways of using a product or service. Hackability allows for the user to become active, to participate and create the tool they want, instead of just passively consume what is provided to them. In a sense, it can be said that the web is hackable by nature. The source code of any web page is sent to the users web browser in clear text, and can therefore easily be modified on the client side. Most modern web browsers even include tools to inspect and modify the structure, content and style of the page. Anyone can easily mess around with the appearance of any given page, customizing it the way they want. With web browser extensions like Greasemonkey[24] and similar, it is even possible to save such modifications, to make the pages you visit render the way you like every time you visit them.

When it comes to designing and developing web services, a good thing to consider is designing for hackability[25]. Imagine a sandbox in a playground. The sandbox is designed in shape and

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[21] Facebook - www.facebook.com

[22] Google Apps - www.google.com/apps

[23] Presentation on Hackability - http://www.slideshare.net/nitot/hackability-what-it-means-why-its-important

[24] Greasemonkey, add-on for Mozilla Firefox - https://addons.mozilla.org/sv-se/firefox/addon/greasemonkey/

[25] Presentation on designing for hackability - http://www.slideshare.net/brianoberkirch/designing-for-hackability

form, and filled with sand and a range of tools to play with, but except from that, the kids are allowed play and do whatever they like, without the designer of the sandbox telling them what to. The same principle can be applied to web services, where the fundamental parts are decided upon by the creator, but where the users are allowed to use and play around with the service however they like. Wikipedia goes along way when it comes to designing for hackability. One thing they do, like many other modern web services, is to provide an extensive API that allow users to not only read data from Wikipedia, but also to modify and delete content, using tools developed by others than the creators of Wikipedia. This is one good thing to do when designing for hackability, however Wikipedia goes one step further in this process. Unlike many other web services and communities, Wikipedia allow any registered user to run custom JavaScript and CSS on the website, that is executed whenever that user is logged in at the site. With the power of modern web browsers and JavaScript, the user is therefore allowed to modify basically any part of the web service, to fit their individual needs.

By designing for hackability, Wikipedia has made it possible for users to implement new features and functionality, like the one described throughout this project. By making use of JavaScript and the open API of Wikipedia, it was possible to implement this project on Wikipedia, making use of actual live data.

# 6.1. Technology used

The idea was to implement the design directly against the Wikipedia website. As Wikipedia support that a user run custom JavaScript, this was a good starting point for the implementation. A possible solution would therefore have been to write the entire implementation in JavaScript, accessing the Wikipedia API directly using AJAX. This however would not be optimal performance-wise, as large amounts of data needs to be processed to generate the section history, putting high requirements on the users computer. The implementation was therefore divided into a front-end, built on JavaScript and running in the client web browser, and a back-end built on PHP running on a web server (figure 6.1). The back-end communicate with Wikipedia through the Wikipedia API, parsing the data and constructing the section history before passing it on to the front-end JavaScript, which then manipulates the Wikipedia interface to make the history available.

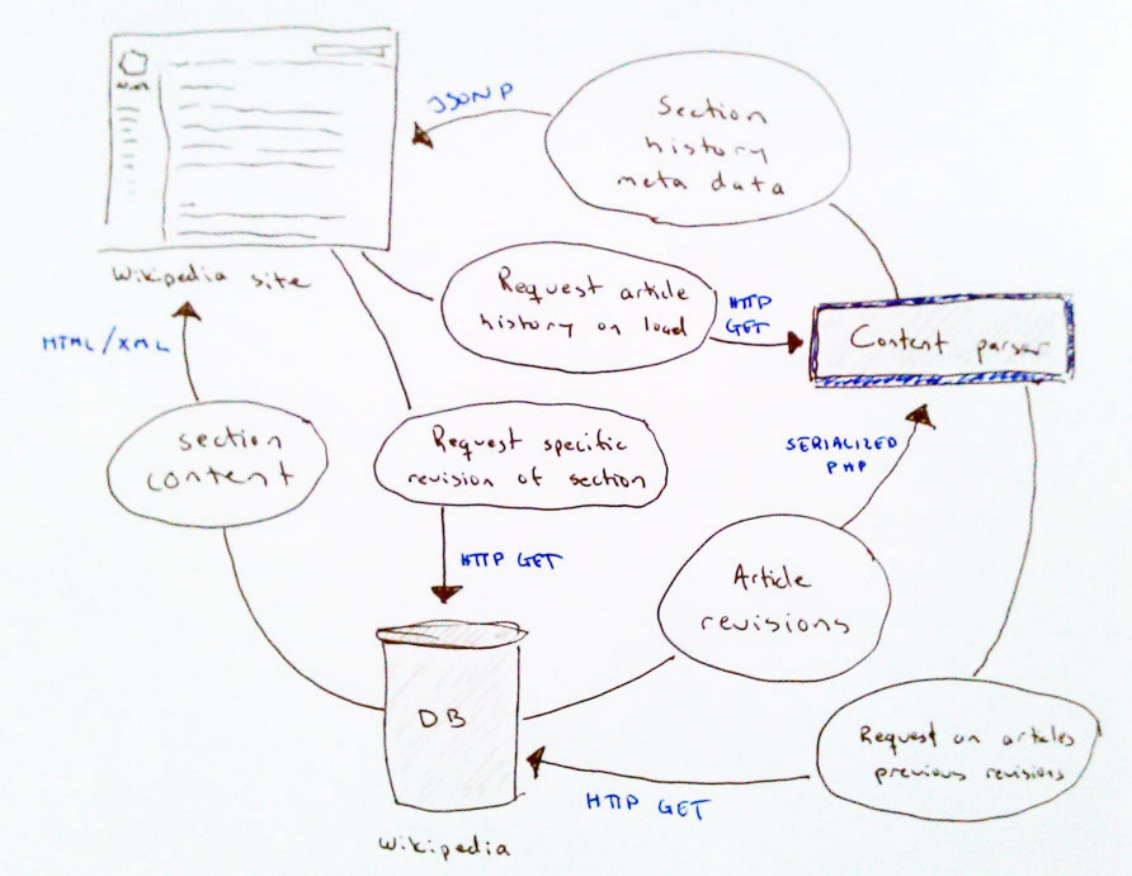


**Figure 6.1** - Early schematic sketch of the implementation. When a Wikipedia article is loaded, the front-end JavaScript execute an HTTP GET-request to the PHP back-end (Content parser). The PHP back-end uses the Wikipedia API to download the revision history of the given article from the Wikipedia database, which is returned as a serialized PHP object. The PHP back-end then construct the article history and passes it back to the front-end JavaScript as a JSON-P object. In case the user chooses to see the content of a previous version, that content will be downloaded directly from the Wikipedia database by the JavaScript front-end, using the Wikipedia API.

### 6.1.1. The PHP back-end

For the back-end of the implementation the scripting-language PHP[26] was used, as both members of the project had previous knowledge and experience with it. The back-end was to act as a proxy between the client browser and the Wikipedia API, to parse the article history and

[26] PHP, Hypertext Preprocessor - www.php.net

construct the history for each section of the article, and then passing it on to the front-end in a suitable format.

For the communication between the back-end web server and the Wikipedia API, the PHP cURL library[27] was used. Data from Wikipedia was therefore fetched through a regular HTTP-request, in serialized PHP format. To save time, a PHP-class for communicating with the Wikipedia API was borrowed from the Wikipedia bot ClueBot[28]. The class contained a range of methods to simplify the communication with the API, and was also extended with new methods throughout the implementation, as new requirements emerged.

To generate the history of each section of an article, the full revision history of that article is pulled from Wikipedia through the API. The current version of the article is then split into sections and each section is stored in an array. Every previous revision of the article then goes through the same process, being split into sections, and every section is compared to the sections of the current version. Every section that corresponds to a section in the current version of the article, but where the content of the section is somewhat different, is stored in the array as a previous version of the section. When all previous versions of the article has been parsed, we have a full version history of the article, divided section by section. For every version of a section, meta-data about that version is stored as well, including information like author and time of creation.

Before the section history is passed to the front-end JavaScript, the PHP array is encoded into JSONP-format, which is more suitable for the front-end. The reason to use JSONP instead of regular JSON is simply a work around to deal with the Same origin policy (see more under implementation challenges).

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[27] PHP, Client URL library - http://php.net/manual/en/book.curl.php

[28] ClueBot, user page - http://en.wikipedia.org/wiki/User:ClueBot

### 6.1.2. The JavaScript front-end

For the front-end implementation JavaScript was used for the main part, to communicate with the back-end as well as to manipulate the DOM[29] to insert the section history into the Wikipedia page. The inserted elements of the section history also needed to get the proper look and feel according to the design, for which CSS[30] was used. To simplify both DOM-manipulation and communication between front-end and back-end, the JavaScript-library jQuery[31] was used. jQuery provide cross-browser compatible functions for everything from DOM-tree traversing to AJAX-communication, which saved a lot of time while developing the front-end.

As a user goes to an article on Wikipedia, the JavaScript will execute an AJAX-call to the back-end, requesting the section history for that specific article. The back-end will fetch the data from Wikipedia, construct the section history and return it to the front-end as a JSONP-object. When the data returns from the back-end, jQuery again becomes useful as it has built-in support for dealing with JSONP. Based on the data that is returned, all necessary DOM-elements for the section history are created and injected into the DOM of the article page. For performance reasons the amount of data processing has been kept at minimum in the front-end. The main purpose of the front-end is simply to capture the data and inject it into the article page, which is a suitable purpose for JavaScript and jQuery.

## 6.2. Implementation challenges

Even though the implementation of the design was relatively painless, a couple of challenges arose during the process. Web browser security measures, limitations in the Wikipedia API and variations in the DOM of the Wikipedia article pages all obstructed the implementation somewhat.

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[29] Document Object Model (DOM) - http://www.w3.org/DOM/

[30] Cascading Style Sheets (CSS) - http://www.w3.org/Style/CSS/

[31] jQuery - http://jquery.com

### 6.2.1. Same Origin Policy

For security reasons web browsers apply to the Same Origin Policy[32] [33], which is a security concept that affect several client-side programming languages, like JavaScript. In principle, the policy permits scripts from the same site to access each other's properties and methods, but prevent such access between scripts originating from different sites. For this project, it was possible to run the JavaScript on the Wikipedia domain. The back-end however had to be run on web servers outside the Wikipedia domain, as Wikipedia only allowed for JavaScript to be run in their environment, not PHP. As the JavaScript was run under the Wikipedia domain and the data about the section history originated from a web server outside that domain, the data was blocked by the browser because of the Same Origin Policy.

There are several ways to allow such cross-site communication, but most solutions would require configurations or installations on the Wikipedia web servers, which of course was not a solution in this case. Instead, the solution was to transfer the data in JSONP-format[34]. JSONP is a complement to the regular JSON-format, or a usage pattern, that allow for data to be fetched from servers in a different domain. This way, JSONP can be used as a work around, to avoid issues with the Same Origin Policy.

### 6.2.2. Distinguishing user types

In the design all users that had contributed to the article were divided into three user types (regular, anonymous and bots), however no module in the Wikipedia API provided such information in a good way. There were modules that allowed listing users of a specific type, but none that could take a group of usernames and return the user types. Therefore, to manage this several measures had to be taken to be able to provide that information in the article history.

The most problematic user type to distinguish was the bots. A bot has a registered user account, but that user account is only registered for a specific language subdomain of Wikipedia, and therefore information about that bot is only available through the API of that subdomain. A bot

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[32] Same-Origin Policy by W3C - http://www.w3.org/Security/wiki/Same_Origin_Policy

[33] Same Origin Policy, Wikipedia - http://en.wikipedia.org/wiki/Same_origin_policy

[34] JSONP, Wikipedia - http://en.wikipedia.org/wiki/JSONP

however is allowed to perform edits on other subdomains than the one it is registered for, so a bot registered on the English Wikipedia may very well perform edits on the Swedish Wikipedia as well. This causes trouble, as you would have to list bots subdomain-by-subdomain, looking to see if a particular user account is a bot. With 281 subdomains at the time of this project, querying one subdomain at a time, every time someone request article history was not an option. To solve this, a database was introduced that kept a full list of all bots listed on any of the Wikipedia subdomains. Instead of performing 281 HTTP-requests against the Wikipedia API, it was possible to perform 1 SQL-query against the database, to determine which users where bots. This was of course a necessity in order to make this work.

The second user type, anonymous users, was somewhat easier to distinguish. For anonymous users the unique identifier is the IP-address, instead of the username as is used for regular users and bots. Using a regexp[35] pattern to match IP-addresses, it was possible to determine if a version was created by someone known by their username or only by their IP-address, thus making it possible to distinguish anonymous users.

For the last user type, regular Wikipedia users, no method was needed to distinguish them. When users had been flagged as bots or anonymous, the remaining users that not yet had been flagged with a user type were simply to be considered being of type regular.

### 6.2.3. DOM-variations between articles

Even though the structure of Wikipedia articles is very flexible, the basic DOM-structure is much the same between articles. However, DOM-variations still exist with some articles having extra elements that other articles does not have. This was a bit of an issue, as it was hard to find a way to always inject the section history DOM-elements in its proper position, as the DOM-tree of the page varied between articles.

[35] Regular Expression, Wikipedia - http://en.wikipedia.org/wiki/Regular_expression

## 6.3. Limitations

As this project was design oriented, with a clear focus on coming up with a proper design for this kind of feature, the time dedicated to development was limited. Due to this some limitations regarding the implementation had to be done in order to meet the project deadline.

### 6.3.1. The number of revisions

As the section history is generated on the fly, large amounts of data has to be fetched over the Wikipedia API and then processed, before the section history can be displayed to the user. Many articles have a considerable number of revisions, making it time consuming to generate the section history. For this implementation to work, the maximum number of revisions to consider was set to 100. For articles with more than 100 revisions, any revision older than the most recent 100 will be ignored. To be able to manage the full set of revisions for every article, generating section history can not be made on the fly, thus requiring some sort of caching to be implemented (see possible improvements for more information).

### 6.3.2. The list of bot users

To be able to distinguish which users are bots, a database was set up that contain all registered bot accounts on Wikipedia. Given the current conditions, this was a necessity in order to do such distinctions. However, using a database instead of the actual live data imply some limitations when it comes to how up-to-date the stored list of bots is. There is a risk that bot users that are very recently registered to Wikipedia will incorrectly be classified as regular users, as they still have not been added to our database. However, the script that add bot users to the database does not take more than a minute or two to execute, so it would be possible to run it every hour, or even more frequently if necessary, thus keeping the delay at a minimum.

## 6.4. Possible improvements

The implementation is still not complete, and a couple of possible improvements exist. The design sketches still contain some features that not yet have been implemented, and some modifications are needed to existing functionality in order for it to work properly.

### 6.4.1. Implement caching

Today the article history is generated on the fly, as a user visits a Wikipedia article. To make this possible, a limitation was introduced, looking only at the 100 most recent revisions of an article. Even so, the time it takes to generate the section history is still too long, and for section history to be meaningful all revisions of an article would have to be considered. With articles having thousands of revision, generating the section history on the fly is not an option if everything should work smoothly.

To manage this, one way would be to implement some kind of caching, generating the section history the first time someone visit the article, and then serve the section history immediately from the cache for all subsequent users. Even though this might smoothen the experience, it comes with a couple of drawbacks. The first time someone visit an article, where the section history still has not been cached, the load time will be long as the section history is generated. Also, depending on for how long you keep the cached section history, there will be a delay, were new revisions of an article are not reflected in the section history.

Another way to manage this problem, that does not require the cache to be generated by the first visitor, would be to crawl Wikipedia, generate section history for every article and keep it in a cache. This way the section history can be served from the cache everytime, without delay for the first visitor. User experience wise, this would probably be the best solution. However, Wikipedia contain millions of articles, with most articles having hundreds or even thousands of revisions. Even if the article content does not have to be cached for the section history, the cache would still have to be massive. It would also require a whole lot of work to keep the cache up-to-date. If the Wikipedia API include a module that provide information about the most recent contributions on Wikipedia, it might be possible to monitor that list, and regenerate the section history for an article as soon as it is changed. That way it would be possible to generate a section history cache for the entire Wikipedia once, and then only update the cache when articles change. In that case, this might be a good solution.

### 6.4.2. Filter the history based on a contributor

In the design sketches it is possible to filter the section history based on a contributor, to display only revisions by a specific user. The idea is to click on a user icon to display his/her

contributions. Due to the limited amount of implementation time, this feature is not yet implemented. Even though such filtering is not critical to the design, it would be a nice improvement to the implementation, as it allows for a different kind of browsing.

# 7. DISCUSSION

In this section, we evaluate the design process of the project and discuss the methods used. The result of the project will also be discussed, in terms of fulfilling the aim of the study and some important and difficult design decisions made throughout the process. After that, possible benefits of visualizing article history on Wikipedia will be discussed, and we will conclude by proposing ideas for future work.

## 7.1. Evaluating the design process

The project started off with some information gathering activities, such as a literature search and a hands on study on Wikipedia. This initial phase of the project was necessary in order to get an understanding of what to design for. It was during this part of the project that we discovered the need for making the history of an article accessible where the users are (i.e. in the article itself), as advised by Jatowt et al. (2008). We were also able to get a good idea of what had been done with Wikipedia data before, which later served as a source of inspiration. Studying Wikipedia provided insights that were crucial to the project, such as how articles are being edited, that there are three types of contributors (registered users, anonymous users and [ro]bots), and what manipulations can be done to the interface by add-on applications. Perhaps a small user study would have been useful in the information gathering part of the study, in order to guide the project in a good direction already from the start. If we would have performed a small study on some Wikipedia users, trying to determine how they would prefer accessing the history of an article, maybe we could have saved some time not exploring a path that was not with the users best in mind. On the other hand, the result of such a study could possibly have limited the creativity, as it might have implied preconceptions about how to solve the problem.

As this project took an exploratory design approach, the aim was not specific about what type of design should be the result. This made the project quite boundless, and allowed for a range of different approaches on how to visualize article history. A couple of weeks after the project had started, it became obvious that the chosen approach was not ideal, too little focus had been paid to the users. Changing focus, and to some extent starting over, did set the project back somewhat

but it was also necessary. If we had not stopped, reflected and acted on what flaws we saw, then the final design would not have been as grounded in the users' needs. Also, realizing this made it possible to later identify one of the early designs as the most suitable for further improvement (the Paper Pile prototype). Perhaps this design would not have been identified as the best one if we had kept a more loose, artistic, idea of what to design. The refocusing put the project back about three weeks, but thanks to a forgiving time plan, the time lost did not affect the outcome to any considerable extent.

The iterative design process made it possible to start of by evaluating a range of different design ideas, without letting too many limitations restrain creativity. For each iteration, the design process became more focused as ideas were evaluated, discarded, or further improved. Nowadays, most designers advocate using an iterative design process, and during this project it was probably as relevant as ever. Taking an exploratory approach, it was necessary to experiment with a range of different concepts, and to select and further improve them over a number of iterations. By working this way, it was possible to allow unconstrained freedom and creativity for while, to evaluate as many ideas as possible, and subsequently working towards a single, final design concept, step by step.

Three main objectives for the project were stated early on, which described what each design should be able to fulfill, and thereby limiting the possible design directions to explore. This was useful, since the limitations actually helped to free our minds, probably because we now had something more framed to think freely about. However, looking back at the design process, the objectives were perhaps not limiting enough. The first part of the design process was spent trying to come up with creative and artistic ways of visualizing historical content in Wikipedia articles. Most of the designs developed during this time were later considered not very usable since they were not developed with the users interests in mind. Perhaps the time spent trying to come up with creative ways of letting history leave subtle marks on the articles could have been used in a better way if the objectives would have been more focused on usability. However, through the very exploration of these design directions, the need for a more user-focused design was identified. In that sense, the first design approaches could have been necessary in order to identify what was wrong in the way the project was first approached. Maybe the exploration was needed in order to be able to identify a more suitable path and to steer the design in that

direction. Also, to be fair, there were not only bad ideas developed during this initial part of the design process. One of the early design concepts - the Paper Pile metaphor - actually lay as a foundation for the final design.

Most of the work of the design process was structured around prototypes. Prototyping was used constantly, for exploring different design concepts, for triggering discussion, to help understand design problems, and for evaluating designs in user tests, to name a few. Constantly exploring new ideas through the development of prototypes was a good way of dealing with the exploratory nature of the project. When a new idea was generated, it could be quickly added to an existing low-fi prototype and then discussed and evaluated. The prototypes were also a useful tool for communicating ideas to people that were involved in the project in different ways, such as our supervisor, Karin Ackerholm (the interaction designer we interviewed), and a number of curious Wikipedia users. The prototypes were also, for obvious reasons, an important part of the user testing, where they served as both a way of communicating ideas as well as trying them out.

When it comes to design methods, one of the most used in this project was the 6-3-5-method. The method was somewhat modified to suit two, and later five, participants instead of the intended six. By adapting the method to a lesser number of participants, but still keeping the idea of generating design ideas in iterations based on what the other participants came up with, the method proved useful, most of all in the first sketch session. When performing a second session with the modified 6-3-5-method, three interaction designers took part, making it a total of five participants. Unfortunately the group session did not result in as many new ideas as we hoped. Even though the participants were not shown any of the early design ideas, many of the design sketches produced during the group session was quite similar to the ones previously created. One possible reason for this is that those ideas were the most obvious ones and therefore first sprung into mind. Further, it took quite some time before the participants fully understood the problem, and therefore much of the time was spent discussing and explaining the problem, rather than finding solutions to it. The plan was initially to run the session for three hours, which would have left more time for the participants to get familiar with the design problem, and to generate new design ideas. Unfortunately, it was hard to find interaction designers that had three hours to spare, and the group session was therefore limited to an hour and a half. That being said, the

second sketch session was by no means useless, and it resulted in some design ideas being generated.

Apart from the 6-3-5-method, several other methods were used in order to generate new ideas and to explore new design directions for the project. These methods include brainstorming, using metaphors, personas and extreme characters. Using metaphors was probably the most beneficial, since it provided some new ways of thinking about the history of objects and how it could manifest itself in objects around us. Personas and extreme characters were not used as thoroughly, they merely helped steer the design thinking in different directions that could be explored by sketching designs suitable for different character types.

To be able to evaluate the designs produced, a first round of user tests was conducted, with six participants. By not choosing participants with little computer knowledge, it was possible to save time by decreasing the size of the user test, without affecting the outcome of the test to any greater extent. The order in which the three design concepts were discussed varied between the different participants. In so doing, none of the sketches were given an advantage due to the order of appearance. This was probably quite important, as the participants often had a hard time understanding the design that was first shown to them. However, when the participants had understood the first concept, they had an easier time understanding the other two designs. Without varying the order of appearance, this could easily have been misinterpreted as the first design being less intuitive and self-explanatory than the others. The results from the first user tests were quite extensive and proved valuable when evaluating the three prototypes afterwards. All of the participants provided useful insights, ideas and thoughts about the prototypes. The fact that some of the participants were more computer-experienced was probably beneficial since some different aspects were noticed by them, not noticed by the other participants.

During the second round of user tests, intended to evaluate a single prototype, four participants were chosen. During these tests, the features of the prototype simply needed to be tested as a combined concept, in order to determine whether this new prototype in fact dealt successfully with the problems discovered in the previous tests. For this, perhaps a larger number of participants would have been preferable, in order to get a more reliable result. However, with a limited amount of time left, and having performed one thorough round of tests including many of

the features tested here, this was deemed sufficient. Out of the four participants in the second user tests, two had been participating in the first tests as well. This was a result of it being difficult to find users willing to participate in the tests, and when two of the participants from user test one were available, they were asked to participate once more, which they gladly did. There were perhaps both advantages and disadvantages of including two users from the first round of tests. One advantage was that these users already were familiar with (parts of) the concept and could therefore also quickly identify different design problems, and determine how well these had been dealt with in the new prototype. However, a disadvantage of using participants who had seen previous prototypes was that they had already been given a description of many of the features before. Therefore, these users could not be viewed as users who saw the design concept for the first time, which had to be taken into account when considering how well they understood the prototype.

In the ideal case, a third round of user tests would have been performed on the interactive prototype, evaluating the final design and to test how well the concept worked when the users were able to freely interact with it. Unfortunately there was no time to perform such tests, which in retrospect is regrettable. However, both the first and the second user test gave clear indications about the most important aspects of the design. Further, feedback has been received from several different sources about the overall concept, both prior to and after the user tests. This information has given a hint that the direction chosen for this project has been suitable, and that the overall ideas are useful.

## 7.2. Evaluating the result

The aim of this project was to make the history of Wikipedia articles visible to the users of Wikipedia, by making history both visual and accessible, inside any article. This was supposed to result in an interactive prototype, demonstrating the design results. There were also three main objectives stated early on, saying that it should be possible to see (for any article), how much the article have been edited, if many people have edited it, and if some have contributed more than others. Looking back at the project, the objectives stated in the beginning have now been reached. A design has been developed through a lot of design sketching, prototyping and user testing. The design makes it possible for Wikipedia users to see, for each section of an article,

how much it have been edited, how many have contributed and how many edits each contributor have made - thus fulfilling the main objectives. Moreover, throughout this exploratory design project, several other features have been requested and added to the design, in order to make it more useful. Such features include the ability to look at previous versions of a section of an article, and the ability to see whether the contributors were registered users, anonymous or [ro]bots. Another feature that was added was the ability for users to see who each contributor was (a username, botname or an IP-address for 'anonymous' users). We believe the design now adds a dimension to Wikipedia that have previously not been easily accessible to ordinary users. The design has also been implemented into an interactive prototype, thus fulfilling the aim of the project. There were, however, no objectives stating that the prototype should be functional in the live Wikipedia environment for any user to try. Therefore, we are glad that the prototype could be made accessible to anyone, live on Wikipedia, which opens up for anyone to also improve upon it in the future.

During the project, several design decisions were made, of which the results can be seen in the final design. One of the most important decisions were to not focus on having the history of an article leave permanent traces in the live content (as first intended), but instead displaying visualizations of historical versions, and making their content accessible. This was not an obvious choice at first, but when user requirements were considered, it became clear that the study needed a new focus - which we believe was beneficial since it helped make the final design more useful. Another design decision was to divide the history of an article into sections, based on the articles' subtopics. We first wanted to show the history of each sentence somehow, but this proved difficult and somewhat hard do combine with our main objectives. Therefore, since most Wikipedia articles are divided into clearly distinguished subtopic, this became a natural choice. A design decision that was made quite late in the project was to make it possible to view the content of previous versions. There were ideas about doing this early on, which can be seen in some of the prototypes, but it was not a stated objective. However, this is a decision we believe made the final design much more useful and interesting to interact with, since the visualized content can be accessed and consumed by the users. Another feature in the final design was to differentiate between registered users, anonymous users and bots. This was a good choice, since it gives the users an insight into how the editing of articles work, which most are not aware of. None of the participants in the user tests knew that many edits to Wikipedia articles

are performed by bots, and neither did we previous to this project. Therefore, we believe the ability to see what kind of user made a certain edit was an interesting and useful feature in the final design.

Some of the design decisions made during the project were more difficult than others to make. Such a decision was that of how different contributors to a section should be visualized. A long way into the project, the idea was to assign each contributor a color, and thereby distinguishing them from each other. When this proved difficult for the users to understand, we had a hard time coming up with a new way of visualizing how many had contributed, and if anyone had contributed more than others (two of the main objectives). This was, however, an interesting challenge and we believe that the final result - with numbers and colors used to quickly identify intervals of edits - is much more suited to fulfill the objectives than was the first idea. Another thing that was somewhat troublesome during the project was to make as much use of as little screen space as possible. The challenge was to fit as much information as possible while maintaining a good overview of the historical content. This was made more difficult by the users having a hard time interpreting the colors at first, which resulted in a need for some kind of explanatory elements in the interface, stealing valuable screen real estate.

Based on the final design, a high-fidelity prototype was developed. Unlike the prototypes used in many other design projects, this prototype was built to work in its intended context, on Wikipedia, and not in a closed test environment. This was made possible by Wikipedia's work on designing for hackability, allowing users to modify and extend the service to their own needs. Not many other applications that can be run live on Wikipedia appears to be available, but the prototype produced in this project can hopefully inspire more designers and developers to follow, adding more custom features to Wikipedia. In true Wikipedia spirit, we believe those apps should be made available to the rest of the user community.

## 7.3. Possible benefits of visualizing article history

In an early conversation we had with people at the Wikimedia Foundation, the organization behind Wikipedia, they requested an easier way for the users of Wikipedia to access the history

of an article, without having to click through the historical content on a separate page. They imagined a solution where users would be able to replay the articles evolution, somewhat like a video. From what we know, no such solution exist today, however there have been projects turning the live content of an article into something similar to a video[36]. Although suggested by Wikimedia, our solution does not make the article history playable. Instead we have focused on visualizing the historical content and giving the users access to previous versions of an article section. That said, nothing in our solution prevents it from being playable as well, and that is a feature that might be interesting to see in the future. However, if the history was to be made playable, we recognize that it will probably be necessary to add some form of time regulator, similar to those available in most media players. Without such regulator, it would be time consuming to browse any part of the history, as the user would have to wait while the history is playing, until it reaches the time of interest.

This project has been about making the article history available to the users of Wikipedia, but are there any benefits to gain by doing so, or is it just an amusing extension? Based on the design work we have done during this project and the opinions gathered during the user tests, as well as our own opinions after trying out the interactive prototype, we see a number of possible benefits of making history accessible.

First, readers of Wikipedia could get a better overview of how up-to-date a certain section is. For instance, if a section about "Upcoming mobile phone models" have not been updated for two years, it is reasonable to believe that the information is no longer valid. Making history available might make it easier to value the accuracy of the information. Even so, valuing accuracy and trustworthiness of the content is not easy, and probably never will be. However, by giving the user access to the article history, the user has a number of extra variables to base their judgment on. From the article history it is possible to determine how many has contributed to the section, if some contributor seems to be more dominant than the others, if some user type is overrepresented among the contributors (anonymous users for instance) and so on. Having access to such information might make it easier to value the content. The design put forward in

[36] Qwiki, project using the live content of Wikipedia articles and presenting them using text-to-speech and images from the articles - www.qwiki.com

this report make all this information accessible, and also split the history based on sections of the article. This makes it easier for the user to value the content of sub-topics of the article, and not only the article as an entirety. We believe this can be useful, as different sub-topics may be subject to different amounts incorrect information. The accuracy of the judgment could therefore possibly be improved by providing the history section-by-section.

Second, editors of Wikipedia might get a better overview of what parts of an article has recently been updated, and what parts have not. By getting access to such information, it might be easier to prioritize the work, as content that not recently has been updated might be in greater need of a review. It may also be the other way around, that editors want to contribute to sections that are being frequently updated, because they want to participate “where the action is”. Whatever the reason, our design supports the need of the editor by providing the date of creation for each version of a section.

Third, some articles on Wikipedia are related to special events like sport tournaments, political meetings and wars, to name a few. By having access to article history, it might be possible to reveal editing patterns that emerge as such events unfold. Further, during rapidly evolving situations like natural disasters, much of the information that is available in an early state, turn out to be incorrect later on. By making historical content available, it would be possible to go back in time and reveal what was once perceived as correct. Together, these three arguments only constitute a selection of the possible benefits of making article history accessible, revealed during this project.

In order to fully interact with historical content, users should be able to view the content of past versions, in order to see what was being said about a given topic, by a certain contributor, some time in the articles' history. Viewing past versions of an article is already possible on Wikipedia today, but the content of past versions is not accessible inside an article, rather one needs to navigate to a page containing a list of past versions. It is neither possible to see historical content of parts of an article without changing the entire article back to an old version. It is by making historical content accessible within an article, while reading it, and divided based on subtopics of the article, that our prototype differs from what have been done previously. We believe that it is important to be able to get the history of any part of an article visualized, for a quick overview,

but also being able to interact with the visualization in order to view the past content. Providing easy access to historical content is perhaps our biggest contribution to the Wikipedia user community. It has all been made possible by Wikipedia, who kept their platform open for hackability and thereby also for creative development of useful add-ons.

## 7.4. Ideas for future work

To extend and further improve the result of this project, we see a number of possibilities for future work. One suggestion would be to add a play feature to the design, letting the user replay the article evolution as a video, instead of manually browsing through the history. This would bring the design somewhat closer to what was initially desired by Wikimedia Foundation. In that case, it would be nice to also add a time regulator, like the one used to control time in most media players, to allow the user to move back and forth in time, watching the article content as it changes. Further, it would be nice to find a better way to distinguish different contributors. Today contributors can be distinguished by hovering the mouse cursor over the user icon, revealing a tool tip with the username or IP-address of that contributor. This solution works, but it would be nice to get a better overview of the contributors, without having to hover the user icon for each individual version. Also, it could be nice to add another level of detail to the section history. For this project, change was considered on section level only. However, it could be useful to highlight the part of the section that was changed between two different versions, for instance by highlighting the text that was subject to modification. Highlighting text has been seen in previous projects (Thomas Adler et al., 2008; Cross, 2006), where text-color and background-color has been used to indicate the texts trustworthiness or maturity, but it has not been used to visualize changes between versions, as far as we know. Future experiments with some of these features could further extend the possibilities provided by our design, and make article history even more useful.

Beyond extending and improving the features of our design, we see a number of ideas for work that approach article history on a more general level. For instance, it would be nice to see someone evaluating the actual benefits of making article history accessible, if there are any. Several previous projects, as well as ours, indicate that there are benefits of doing so, but a thorough evaluation of them would be both interesting and useful. The result of such a study

would also be a corner stone when it comes to fully understanding the users needs, in order to further improve the design we put forward here. In relation to such work, it would be nice to use our implementation, or any other similar implementation if available, to perform a quantitative user test, gathering information about how and when users tend to look at article history. With the users consent, only smaller modifications would have to be made in order to gather such data, from a possibly very large user group, as the implementation easily can be added to Wikipedia by the users themselves. The results of such tests could then also be used to further understand the users, thus laying the foundation for further improvements to the design.

Within this project, content history has been considered for Wikipedia articles only. However, several other types of content on the Internet are also subject to change and collaboration between different contributors. Blog posts, news articles and Google Docs documents may all be subject to continuous change and similar collaboration patterns, thus possibly benefiting from making the content history available. It would therefore be interesting to see some work that take the thoughts from this project and other projects related to article history and apply them to other contexts. We believe that many of the thoughts put forward in this report are applicable also in other contexts than Wikipedia, although the design and implementation may have to be modified to fully suit the users needs.

# 8. CONCLUSION

The aim of this project has been to, through an exploratory design study, explore how to make history easily accessible to the Wikipedia user community. The design study was supposed to result in a final design, that then could be implemented into an interactive prototype. Three main objectives for the design were stated; to give users the ability to see how much an article has been edited, how many contributors took part, and whether some contributors were more involved than others.

The work was conducted as an exploratory design study, where a large number of design ideas were generated using a range of different design methods. Every design was realized as sketches and low-fi prototypes, and the most promising designs were evaluated together with potential users. The feedback from the user tests was used to improve the designs further. After a number of iterations, a final design was reached (figure 8.1), that visualizes the history of any Wikipedia article and makes it easily accessible for the Wikipedia users, in a way that has not (to our knowledge) been done before. The main features of the design are:

- **History is displayed for each subtopic**, which makes it possible for users to look closer at any subtopic of an article and explore the historical content of the subtopic.
- **Contributors are divided into three types**, being registered users, anonymous users and [ro]bots. Thus making it possible for users to see whether a historical version of a subtopic was edited by a person or a bot. This also provides users with an insight into how the editing of articles works (with different kinds of contributors), which most are not aware of.
- **History is made visual in the articles,** and could therefore be viewed by the users as they are reading an article. This gives the Wikipedia users the ability to evaluate the content of any part of an article based on who, and how many have contributed to the content.
- **Historical content is easily accessible** for the users, thereby providing them the opportunity to not only see who did what, and how much have

been done, but also to see the actual content of any past version of an article. Thus, making the design more interesting and useful to interact with.

Making the history of an article easily accessible has several possible benefits. One benefit is that it could make it easier for users to value the content in terms of trustworthiness. It could also help editors of Wikipedia evaluate what parts of an article needs improvements by providing a better overview of what has recently been updated, and what has not. Another possible benefit is that users could reveal editing patterns that emerge as events unfold, and it might be possible to go back in time to reveal what was once (perhaps falsely) perceived as correct.

The design results were made available to the Wikipedia community as an interactive prototype, usable live on Wikipedia. This shows that when large web services open up for hackability, it becomes possible for others to build their own extensions to the service, thus improving the service and benefiting other users if made available. Further, during the study indications were found that having access to an article's history can be both useful and beneficial to the users. Having access to content history has been requested in previous studies, and we see no reason to doubt the benefits put forward in those studies.

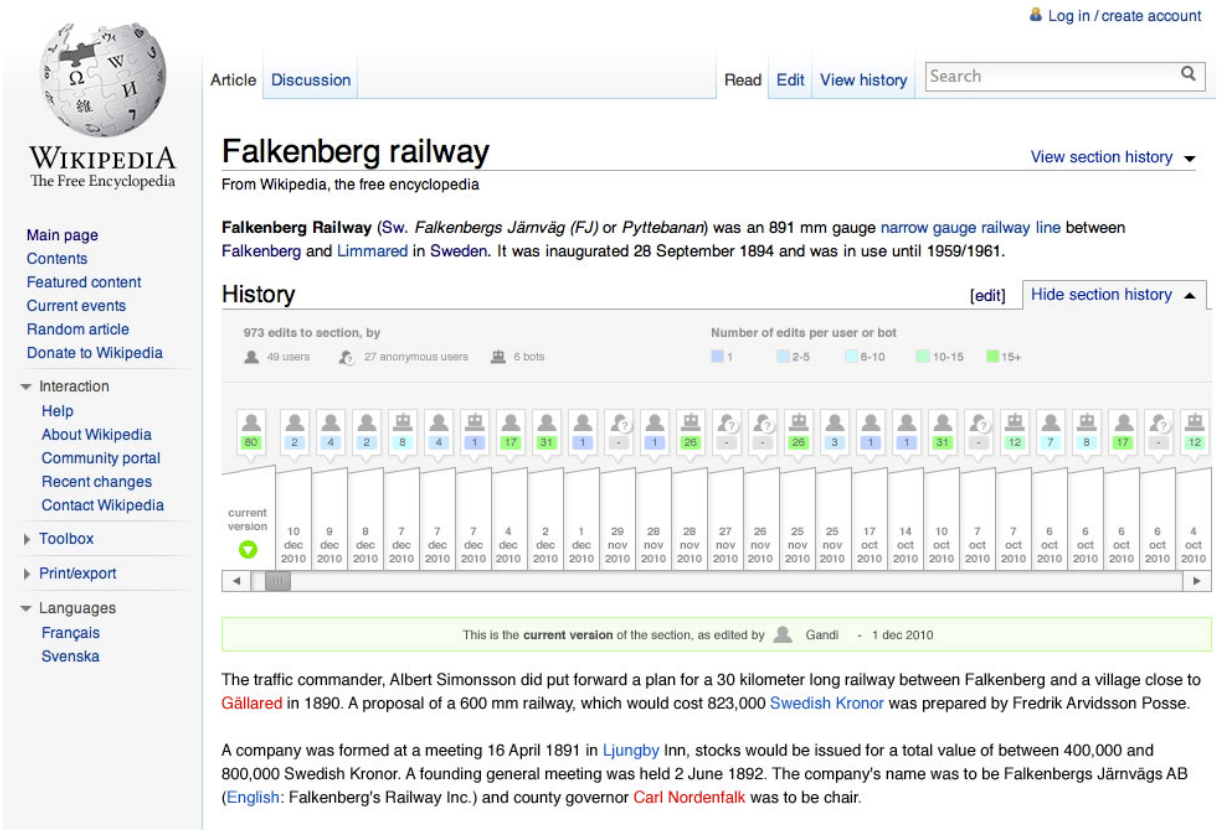


**Figure 8.1** - Final design, where the user has chosen to reveal the section history.

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# APPENDIX A: STRUCTURE OF THE STUDY IN DETAIL

The study was mainly divided into three parts, where the first part was about gathering information and understanding the problem area. This was done by looking through previous research and by browsing Wikipedia, to thoroughly understand the mechanisms behind its usage. The second, and most extensive part of the project focused on design and exploring different ways of visualizing historical content. A range of design concepts was evaluated, and at the end an interactive prototype was developed and tested with Wikipedia users. To conclude the study, a few weeks were used to gather and analyze the results of the design work.

## Information gathering

The first weeks of the project were used to gather information about Wikipedia and its community, and what previous research had been done in the area. Further, information about data visualization and especially visualization of temporal aspects needed to be obtained. To be able to understand the problem at hand and the challenges within the design task, gathering such information was necessary, prior to entering the design part of the project.

To understand the forces and mechanisms behind Wikipedia, and to learn what is important when browsing and editing the content of the encyclopedia, the natural way was to become part of the community. A week was therefore spent browsing through content and its previous revisions, editing articles and discussing article improvements on Wikipedia's discussion pages, and reading through guidelines and policies[37]. Extra time was spent on examining how Wikipedia makes previous revisions of an article available today, and the positive and negative sides of that solution.

[37] Policies and guidelines for Wikipedia - http://en.wikipedia.org/wiki/Wikipedia:List_of_policies_and_guidelines

A two week information search session was also conducted, as Jones (1992) suggest, any information search that is planned to last for more than a few hours should have a predetermined purpose. The purpose of this session was to obtain greater knowledge about Wikipedia and previous research conducted on the community, as well as about data visualization, especially with focus on temporal aspects. Information about previous research on Wikipedia was primarily retrieved through ACM[38] and Google Scholar[39]. What articles to read were initially prioritized based on the relevance of the articles title and abstract, and later also by the repute of the author, as suggested by Jones (1992). Information and inspiration on data visualization was primarily gathered through books on the subject, and through websites showcasing different visualizations.

# Design

Since the study was of an exploratory nature, there where no obvious objectives to guide the design process. Therefore, a session of Stating objectives was performed in the beginning of this part of the study, in order to frame the objectives for the design somewhat. Jones (1992) mentions that user interviews could be used as a complement to Literature searching in order to get an understanding of the situation, before stating essential objectives. However, since a literature search was conducted in combination with a hands-on study on Wikipedia where the role of active user was explored, the information to base the essential objectives on were considered sufficient.

Based on the stated objectives for the design, a first sketch session was conducted in order to get a common visual understanding of the problem and to produce some material for discussion. For the session, a downscaled version of the 6-3-5-method was used, where the two authors participated, developing sketches in three rounds of five minutes each. In between each round, one minute was spent getting familiar with the sketches handed over by the other participant. The objective with each round was to sketch the first things that came to mind, coming up with various design concepts that could be further developed and explored in later rounds. The first sketches were discussed and evaluated, and new inspiration was sought through an inspiration

[38] ACM Portal, a search engine for academic papers - http://portal.acm.org/

[39] Google Scholar, a search engine for academic papers - http://scholar.google.com/

search in information visualization literature as well as in online information visualization resources[40] [41] [42] [43].

Following some sketching based on the inspiration search, a KJ-method session was held, evaluating all sketches produced so far. The KJ-methods was chosen since it produces a result where similarities can be identified, grouped together and given a label. Because of the exploratory nature of the study, with many loose ends at this early stage, labeling the various design ideas and - in a following brainstorm session discussing their value - was considered useful. As a result of the KJ-method and brainstorm sessions, the objectives for the design were refined somewhat. Further sketching was then conducted, in order to explore new possibilities and new directions for the design, with the new objectives at mind. To remove some mental blocks and to think somewhat outside the box, the method of using metaphors were chosen. Following the development of a number of low-fi paper prototypes throughout numerous sketch sessions, a second 6-3-5-method session was held. This time, the goal was to get some of new design ideas by picking the brains of some other interaction designers, during an organized sketch session. An invitation to a free lunch in exchange for some ideas and an hour of their time was sent out to interaction designers in the vicinity. Three of the invited designers wanted to participate, making it a total of five participants including the two authors. All participants where given screen prints of an actual Wikipedia article, as a guide for their design sketching. The session was divided into three parts (with a given topic for each round), and each part was carried out in two rounds of five minutes each. After five minutes, the participants where asked to send their sketches to the person sitting right of them. One minute was spent familiarizing with the received sketches, and then the second round of five minutes started. After each part, the task and the produced sketches were discussed in the group, before starting the next part. In order not to influence the participants initial way of thinking about the problem at hand, the two authors did not participate in the first part.

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[40] Visualization Magazine: http://visualisationmagazine.com/blogvisualthinkmap/

[41] Infosthetics: http://infosthetics.com/

[42] We Love Datavis: http://datavis.tumblr.com/

[43] Information Is Beautiful: http://www.informationisbeautiful.net/

Based on all design ideas produced so far, three low-fi prototypes were developed. The prototypes were then used as a ground for discussion in an unstructured interview with Karin Ackerholm, an interaction designer at inUse[44] whose brain we had the opportunity to pick at two occasions in the project. Karin was asked to provide feedback and give her thoughts on the project so far. Based on the feedback from the interview, a brainstorm session was conducted in order to provide the study a stronger user focus. The requirements of different users types were then listed and prioritized in terms of which to focus on during future design activities.

These designs where then further improved and modified through sketching, this time with a stronger user focus. Some of the techniques were used in order to remove mental blocks, which included Extreme characters, Personas as well as using limitations to trigger exploratory thinking. The best prototypes design so far where chosen and used in a second unstructured interview with the Karin Ackerholm, where they were discussed and evaluated. Then, more prototype sketching took place dealing with the issues discussed in the interview, producing a total of three prototypes.

To be able to evaluate and choose one of the prototypes for further development a first round of user tests was conducted. To avoid problems, a test round was conducted where the test was evaluated on two participants. Six participants were then chosen for the actual tests, each of them being frequent Wikipedia users. None of the participants had, however, contributed to Wikipedia as editors of an article prior to the interview. The group of participants was chosen to contain three people with medium computer experience, and three people with expert computer experience. Users with no or little computer experience were not invited to participate, as they were not considered a primary target for this kind of feature. Among the computer experts, two of the participants were interaction designers and one was a programmer, which resulted in input and opinions with different perspectives. During the tests, the three prototypes were shown to the participants, one concept at a time. The tests were conducted as a mix between a user test and a semi-structured interview, where the participants were asked to explain the design concept and how it worked, without prior explanation. The purpose of the tests was to see if the design was

[44] inUse, a digital bureau focusing on interaction design, usability and effect management - www.inUse.se

self-explanatory, and if all information was conveyed through the visualization. The tests were recorded using either a laptop or a mobile phone, and then transcribed.

Data from the first user tests were then analyzed during a KJ-method session, with which the aim was to identify pros and cons for each of the three prototypes, based on the transcripts from the interviews. During the following design sessions, all prioritized aspects were taken into account and dealt with, producing one low-fi prototype to test in a second round of user tests before developing it into an interactive prototype. A second user tests were then performed, in order to evaluate the prototype in terms of how easy the new concept was to understand, and what parts of it could be further improved. Since many features in the design were derivatives of features in previous designs, many of them had been tested out earlier. Therefore, it was considered sufficient using only four participants for these user tests - two from the first user tests, and two who had not seen any previous prototypes. The tests were also less thorough and were seen more like a way of communication with the users than extensive testing. Similar to the first tests, all of the participants were frequent Wikipedia users, but none of them had contributed to Wikipedia as editors of an article before. The two participants that had *not* participated in the first user tests could be considered having expert computer experience, and the two participants from the first user tests where considered having medium computer experience. The tests were conducted in a similar way to what was done in the first user tests, with the prototype shown to the participants who were then asked to try explaining the design concept and how it worked, without prior explanation. The prototype was then discussed with the users to see how well they understood it and what they liked and disliked about it.

After the tests, the design and development towards an interactive prototype, based on the design concept tested in the second user tests, could commence. As the backbone structure of the prototype was being built, the design was continuously improved throughout iterations of design sketching in Photoshop, discussions about features in the design, followed by redesigning and then development of interface components. These iterations continued until the entire interface was formed, as well as the backbone structure, completing the interactive prototype.

# Concluding work

To conclude the study, the last weeks were used to gather and discuss the knowledge that had been obtained during the design process, as well as during the information gathering. The suggested design was also compared and discussed in relation to previous related work, to elucidate differences and similarities between the results of this project and previous studies. Further, the chosen work path and the methods used, both academic- and design oriented, were discussed regarding how much they had contributed to the project. Possible ways to improve the work process were discussed as well, as it might be of interest to people taking on similar tasks. Finally, ways to extend the study and to improve the design concept were discussed, and topics for future work were suggested.